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POWER AND THE ENGINEER

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Vol. 29. Index to Advertisers and Classified Index Following Reading Matter No. 21

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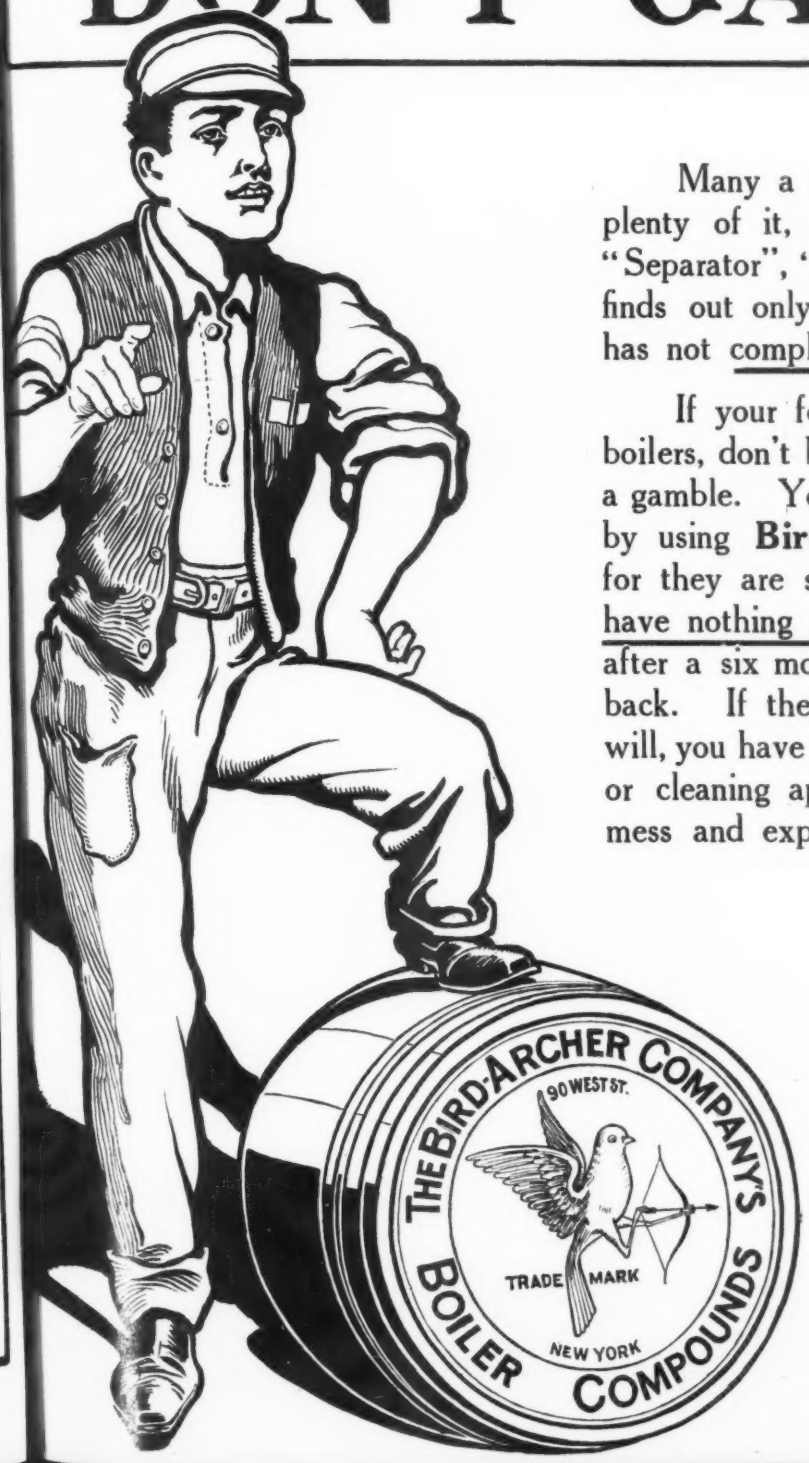

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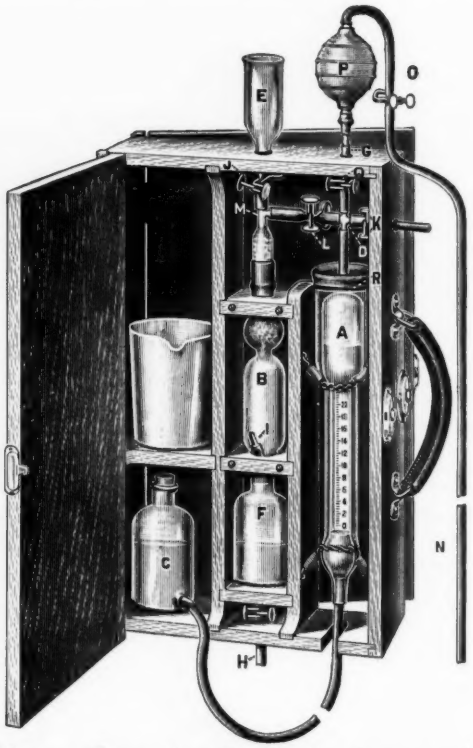

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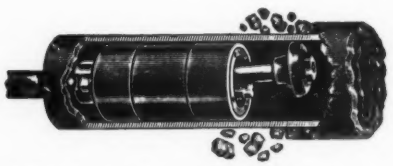

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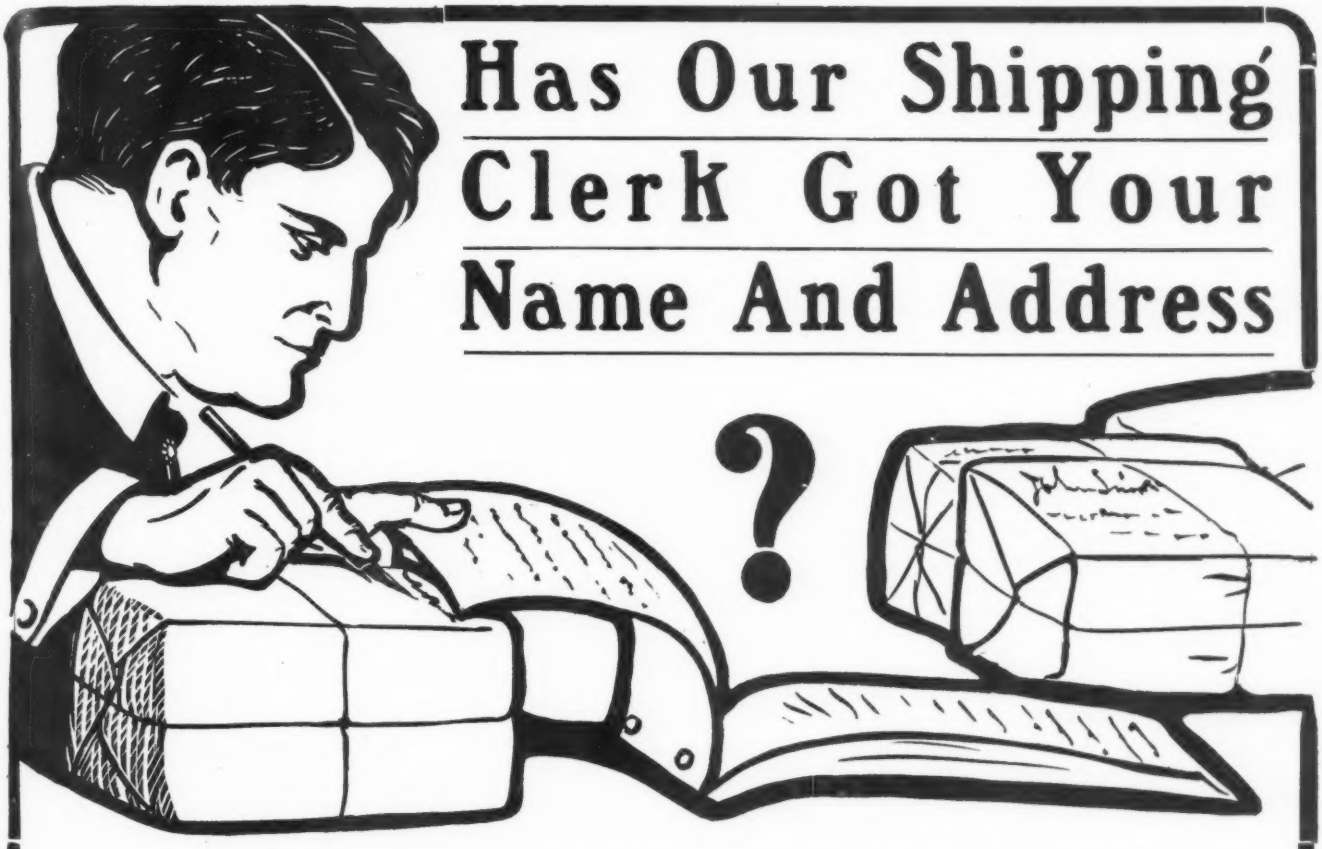

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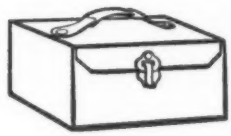

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Its width . . . . .
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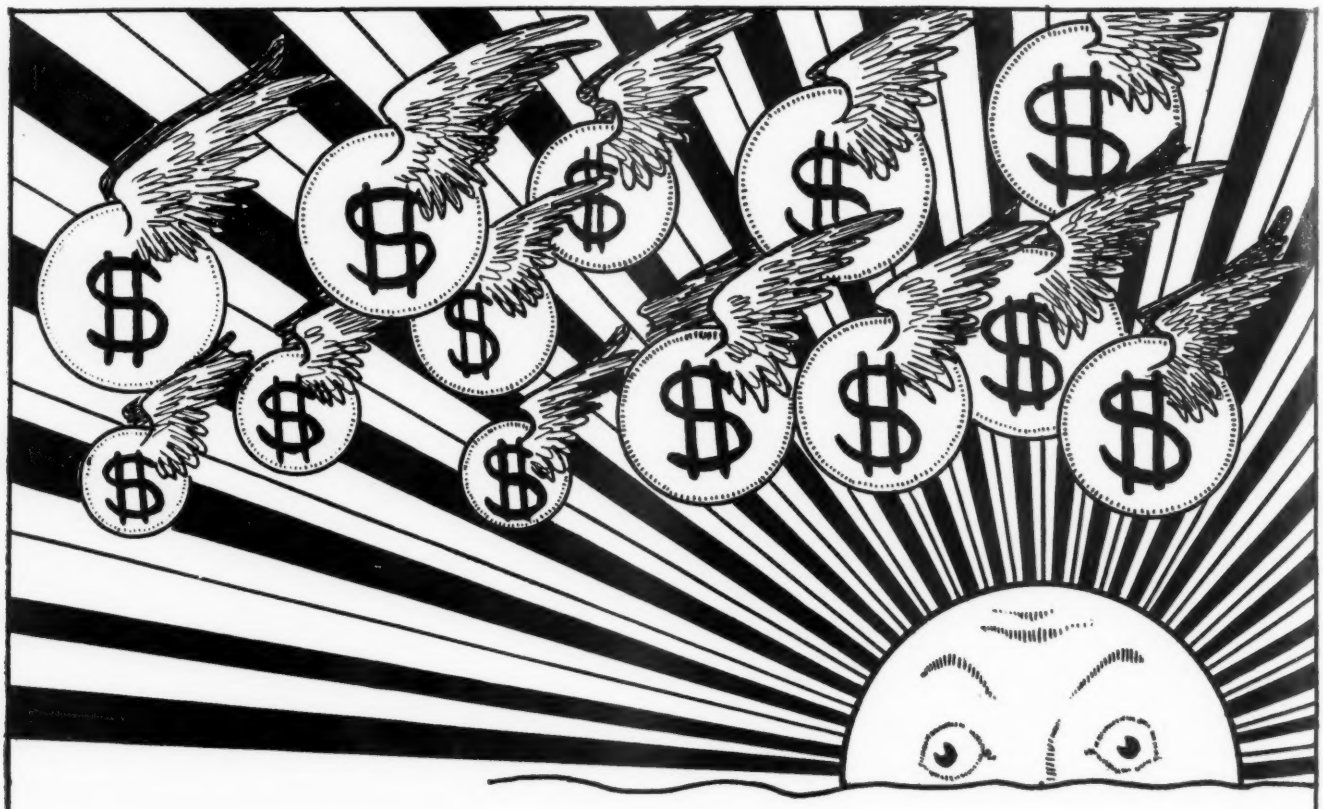

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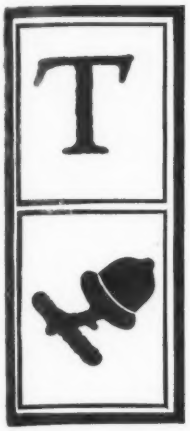

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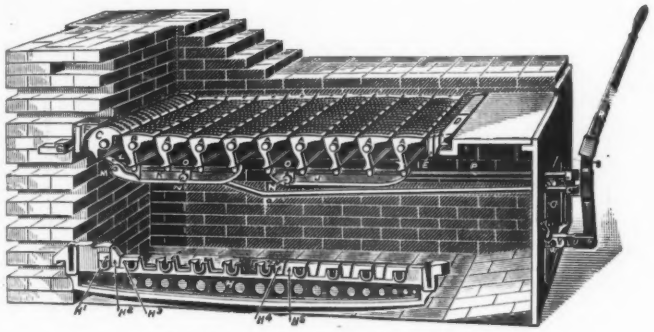
The McClave Grate



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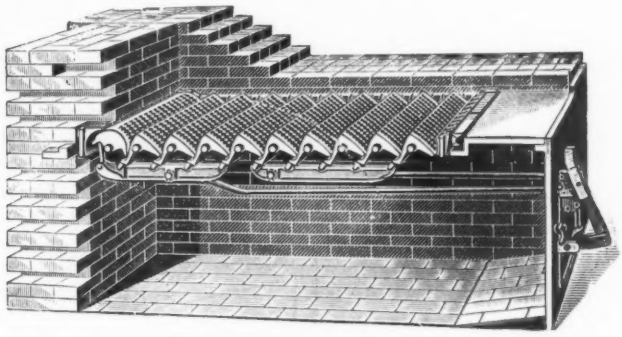

Plate No. 2. Shaking Movement.

Argand Steam Blower.

The Argand Blower

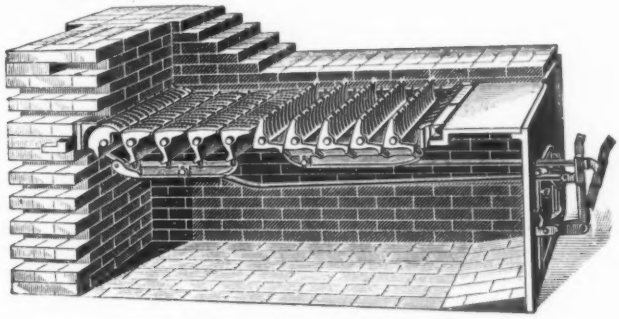

Plate No. 3. Divided Cut-Off Movement.

secures from any cheap grade of coal the results which, with other grades, would require the very best obtainable fuel.

As there is absolutely no waste the McClave System pays for itself in a surprisingly short time.

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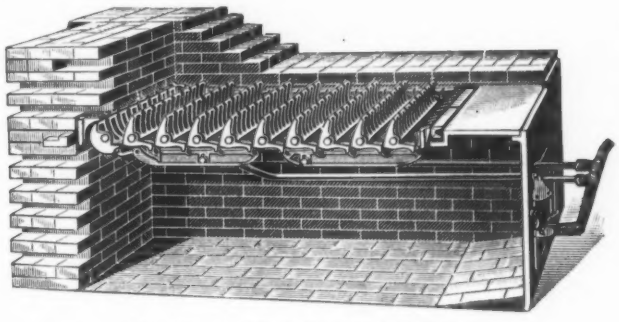

Plate No. 4. Whole Cut-Off Movement.

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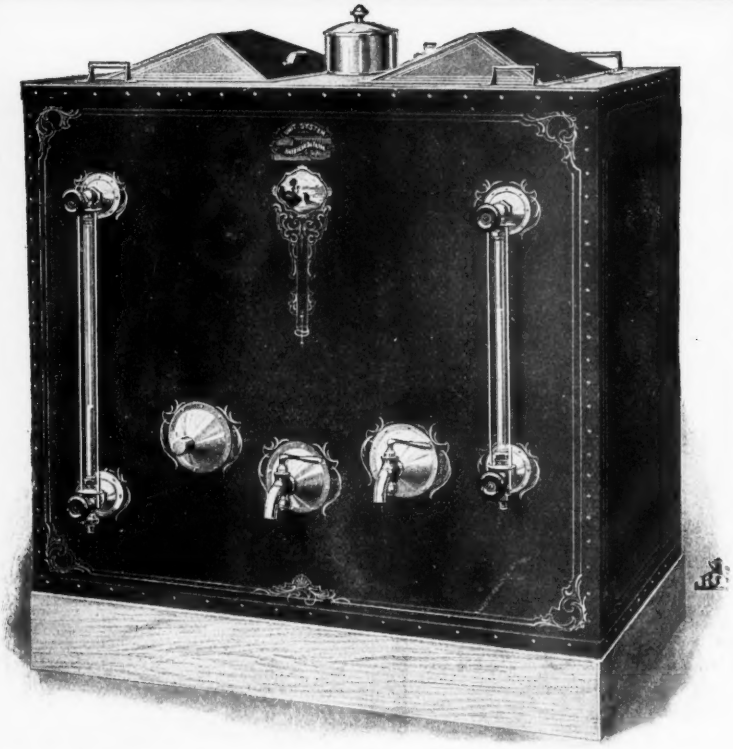

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The U. S. Steel Corp. has recently sent us their 9th order calling for 15 Units.

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Burt Exhaust Heads are used by the British and U. S. Governments; the U. S. Steel Corp. has 102 of them in daily use, and the Baldwin Locomotive Works uses fifty-five.

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The New Eyermann Steam Turbine

A Combination Action and Reaction Turbine Using Only One Rotating Disk on Which Vanes are Arranged Radially and Concentrically

BY DR. ALFRED GRADENWITZ

A novel steam turbine, recently constructed by Messrs. Swiderski, at Leipzig-Plagwitz, on plans by W. H. Eyermann, a Berlin engineer, has been tested by Prof. E. Josse, of the Charlottenburg Technical High School, its output being 250 metric horsepower at 3000 revolutions per minute, an admission pressure of 10 atmospheres absolute and an absolute back pressure of 0.1 of an atmosphere. This turbine, which has been in operation at the works of the maker since the beginning of 1906, shows some decided departures from familiar turbine practice and a number of novel and remarkable attachments.

Generally speaking, the conversion of the energy of the steam into mechanical work is effected either by accelerating the steam jet in a nozzle (converting the

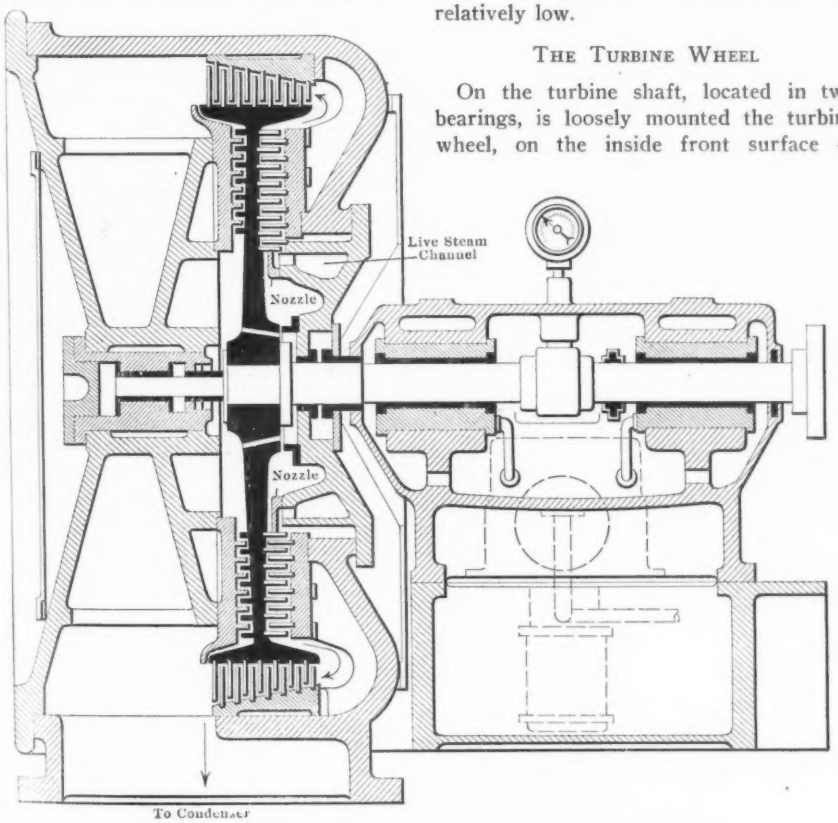


FIG. 1. EYERMANN TURBINE OF 5000 HORSEPOWER CAPACITY

speed energy thus imparted to it into mechanical work by deflection from a moving vane) or by causing the steam leaving the vanes to act in virtue of its energy of flow both by action and reaction. In the former case, which is that of impulse turbines, there are two usual methods, that in which a considerable pressure gradient is converted by a nozzle into speed, the steam jet being deprived of its energy by one or more running wheels* or that in which the pressure fall is subdivided into several stages, the nozzle being replaced by a number of guiding and running vanes arranged behind one another.†

The Eyermann turbine partakes of the properties of both systems and can be considered as a combination of an action turbine in the upper stage with a reaction turbine in the lower stage, the essential difference from all existing turbines being the use of only one rotating disk on which the vane systems are arranged radially and concentrically. Its space and weight requirements are accordingly reduced to a minimum and its cost of construction is relatively low.

The Turbine Wheel

On the turbine shaft, located in two bearings, is loosely mounted the turbine wheel, on the inside front surface of which are located the vane rims of the low-pressure turbine, while those of the high-pressure stage are fitted on a rotary support of L-shaped cross-section, which is bolted to the turbine wheel. After traversing the regulating valve, the steam is supplied to the high-pressure stage through four nozzle systems arranged concentrically round the shaft, insuring a partial impact on the circumference of the wheel. Each of these systems comprises a number of nozzles in which the

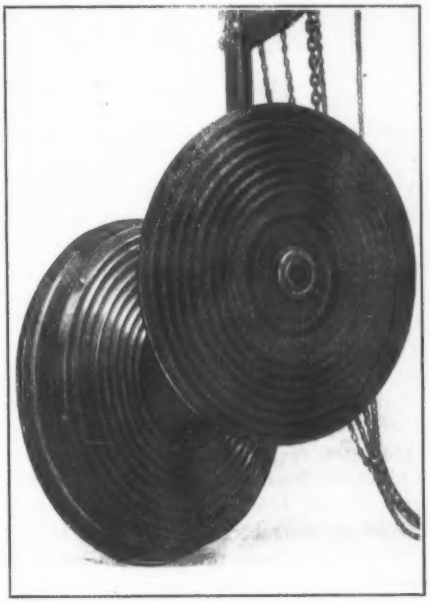


FIG. 2. CONSTRUCTION OF TURBINE WHEEL

steam undergoes an expansion down to about 1.5 atmospheres absolute. The energy thus obtained is absorbed by the high-pressure wheel in two- to three-speed stages. The high-pressure wheel likewise comprises a number of vane systems, which are all turned toward the low-pressure vanes. The steam traverses the speed stages flowing toward the center of the wheel, the vanes increasing in hight, so as to obtain the increase in cross-section corresponding to the speed gradation.

The pressure gradient still left for utilization down to the pressure of the condenser is utilized in about seven to eight reaction stages in a similar manner to the case of the Parsons turbine, the steam now flowing from the center outward through the sets of running vanes arranged radially on the front side of the turbine wheel. The steam issuing from the whole of the outer circumference of the wheel penetrates into an annular space, whence it is conveyed to the condenser.

*De Laval, A. E. G. and Curtis turbines.
†Rateau and Zoelly turbines.

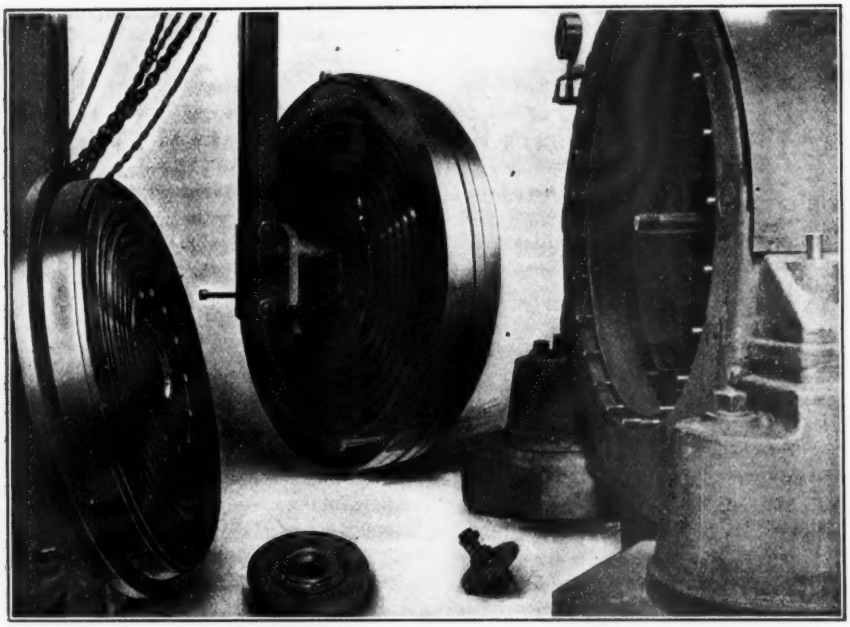


FIG. 3. INTRODUCING THE TURBINE WHEEL INTO HOUSING

Radial Arrangement of Vanes a Material Advantage

A material advantage insured by the radial arrangement of the vanes in the low-pressure turbine, is the fact that the increase in vane section required with a view to the increase in steam volume, at the beginning, is partly obtained by an increase in the wheel circumference, there being the additional possibility, which has been taken advantage of by the constructor, of adapting the passage cross-section to the increase in volume by increasing the hight or altering the inclination of the vanes. Those belonging to the lowermost stages thus become far lower than those of the Parsons turbine, the circumferential speed of the vanes increasing continually on account of the radial arrangement. Between the turbine wheels and the support of the high-pressure vanes is located the guide-vane support, viz., an annular cast-iron piece centered with and bolted to the turbine housing.

Apart from the simplicity and compactness in the construction of the turbine, which is due to the use of a single turbine wheel, the fact that all the vanes are at right angles to the front surface of the wheel, affords the additional advantage that the guiding and running vanes are strictly parallel to one another, so that the steam jet deflected from them meets with a constant cross-section in any vertical element of the vane. The working of the steam jet accordingly is more satisfactory than in the case of axial turbines, with their greatly diverging running vanes and relatively small wheel diameters. In fact, the arrangement adopted by the inventor makes the circumferential speed in all the vertical elements of the horizontal guiding vanes practically constant, and the energy is accordingly utilized more perfectly than in the case of axial-flow turbines.

It is true that in the case of the new turbine the vanes are put to a higher strain than with other arrangements, which limits their possible hight. The vanes being arranged horizontally are exposed to the inflection strain due to the centrifugal force and in the second place to that due to unbalanced pressure in front of and behind the vane, as well as to the thrust produced in the path of the steam, whereas in the case of the ordinary axial arrangement of the stages, the centrifugal force results only in a pull on the vanes, which is far more favorable The maximum hight of vanes had accordingly to be ascertained especially.

Inflection Strain on Vanes

According to Professor Josse's calculations, the inflection strain due to the centrifugal force on the vanes, which at the extreme circumference are 0.708 inch in hight, is about 5700 pounds per square inch. As the load on a turbine is continuous and one-sided, an inflection strain of up to 1000 kilograms per square centimeter (14,223 pounds per square inch) with vanes about 1¼ inches in hight, would seem to be quite admissible. This, however, would suffice for an output of up to 1000 kilowatts, while in the case of

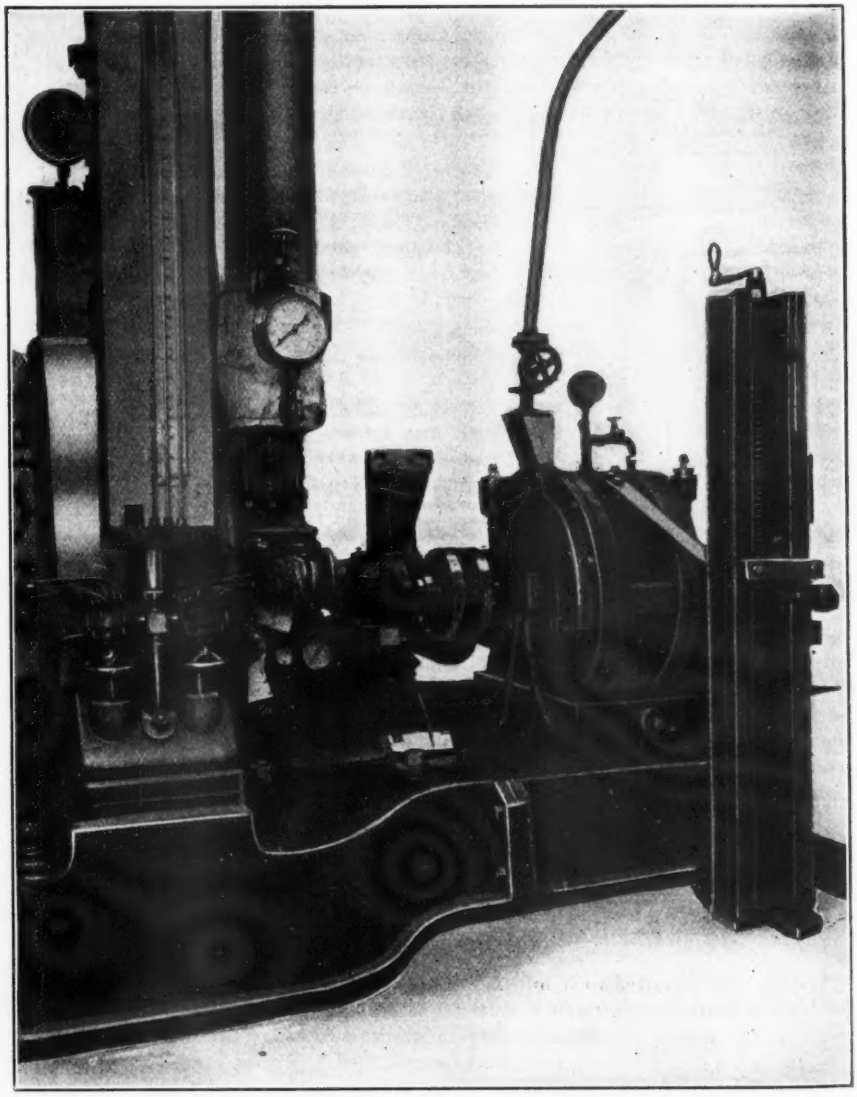


FIG. 4. DIRECT-COUPLED HYDRAULIC BRAKE FOR TESTING TURBINE

greater capacities, a narrow axial drum for the lowermost stages should be connected to the turbine wheel. In the case of a turbine of 10,000 kilowatts, the width of this drum would not exceed 15¾ inches.

The arrangement of the vanes on one of the front surfaces of the vane disk, in the case of the turbine tested by Professor Josse, involves an inflection strain on the vane disk, which has been compensated by the inventor in a simple and ingenious manner by means of reinforcing ribs, fixed on the back of the turbine wheel opposite the vanes. These, owing to their inertia, produce an inflection torque identical with that of the vanes, but opposite in direction, so that each sector of the wheel is subjected to a pull. These reinforcing ribs are designed as a large number of segments. Owing to the arrangement above described, the bulk of the turbine disk can be considerably reduced.

The radial play between the guiding and running vanes is kept constant at about 1 to 2 millimeters (0.04 to 0.08 of an inch), the running disk being centered by the shaft and the support of the guiding vanes by the housing. The amount of play is quite sufficient for the maximum thermic expansion.

Compensating One-sided Steam Pressure

The arrangement for compensating the one-sided steam pressure and maintaining the rotating disk in a central position, free from any friction, is ingenious. While the steam coming from the high-pressure stage passes to the low-pressure stage through annular apertures in the support of the guiding vanes, a small portion of the steam enters, at a pressure of about 1.5 atmospheres absolute with full load, into the intermediary compartment provided behind the support of the high-pressure vanes between the latter and the turbine housing. This steam flows round the back of the high-pressure disk and is conveyed by a regulator to the back of the low-pressure wheel with a view to keeping the latter in a central position, dealing with the axial pressure and preventing any outward radiation of heat from the turbine. The steam then traverses a throttling section constituted by two plane surfaces placed a short distance apart on the hub of the running wheel and the turbine housing, respectively. After passing through the throttling section, the compensation steam passes through openings in the hub to the back, and thence in a radial direction to the circumference of the wheel, whence it escapes into the condenser. In this connection, it traverses the profiles due to the compensating ribs which are provided with a number of labyrinth packings.

A somewhat different plan has been adopted in the turbine submitted for testing, in which the steam after passing through the throttling section gets through radial apertures in the turbine shaft into an axial bore of the latter, and after passing through the shaft to the back of the turbine wheel, is again introduced to the circumference of the turbine disk.

The amount of steam traversing the throttling cross-section depends on the dimensions of the latter, that is, on the play between the two plane surfaces and on the over-pressure of the steam in front of and behind the running disk, respectively. Though the steam escaping from the back of the turbine wheel does not perform any mechanical work, it is used economically in maintaining the wheel in its central position, in dealing with the steam pressure, which acts on one side of the vanes, and in making up for losses due to radiation.

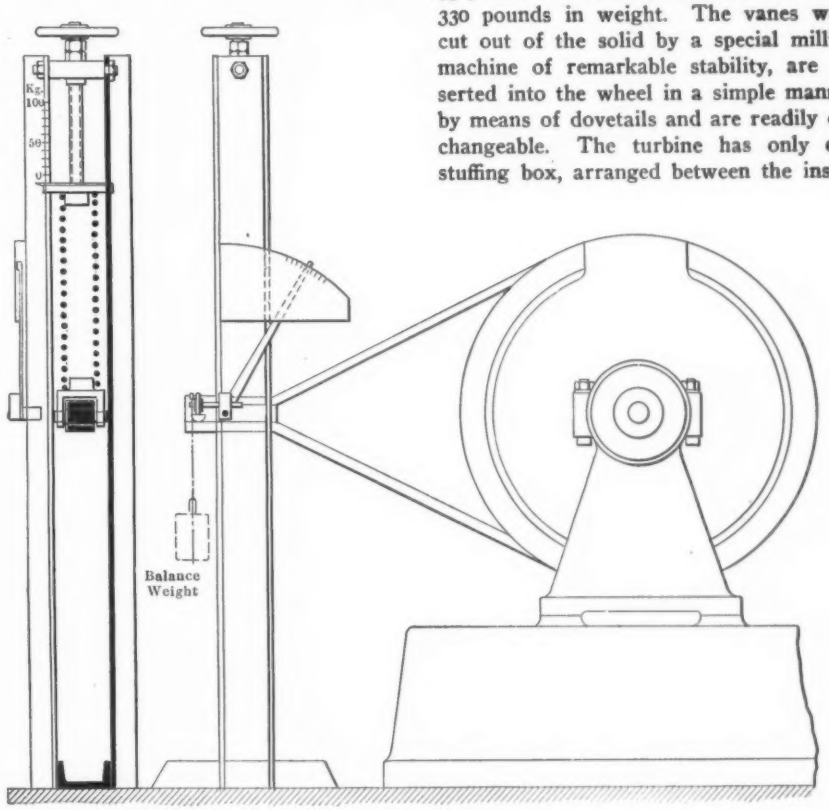


FIG. 5. OUTLINE SKETCH OF BRAKE

The central position of the turbine wheel is secured in the following manner: Supposing the wheel to be moved to the left under the action of the one-sided steam pressure, the cross-section being increased, a greater amount of steam would be allowed to pass while the play in the compensating compartment is reduced, thus augmenting the steam pressure in the latter and throwing the wheel to the right. The opposite takes place in the case of a right-hand motion of the wheel, and this undergoes minute axial vibrations, which in certain cases can actually be observed and which are damped by an oil buffer acting against the axial motion of the wheel. It may be said that a certain loss of steam is involved by the compensation steam escaping into the condenser without performing any useful work, but similar losses are present in all other reaction turbines. As it is, the results of Professor Josse's tests show those losses to be quite immaterial. The friction acting against the rotation of the turbine disk is accordingly eliminated in a very efficient manner.

Construction of Turbine under Test

The turbine tested by Professor Josse comprises in the high-pressure portion three speed stages and in the low-pressure portion eight reaction stages. Its wheel is made of Siemens-Martin steel and is 35.4 inches in outside diameter and about 330 pounds in weight. The vanes were cut out of the solid by a special milling machine of remarkable stability, are inserted into the wheel in a simple manner by means of dovetails and are readily exchangeable. The turbine has only one stuffing box, arranged between the inside bearing and the turbine disk for holding the steam pressure behind the nozzles.

The rotating parts of the Eyermann turbine are of low weight and apart from the vanes are mainly manufactured on the lathe. The tests show that the steam consumption and the thermal efficiency of the turbine is quite equivalent to those of other systems.

Steam Consumption

The effective output of the turbine was ascertained by means of a hydraulic brake designed by Eyermann, which was directly connected to the turbine shaft by means of a fixed disk clutch. The inside circumference of the brake housing carries vanes susceptible of being rotated from the outside. The capacity of the brake is adjusted within wide limits by

altering the pitch of the vanes. A permanent flow of water traversing the brake housing serves as resistance to the braking disks and also carries away any heat produced. The torque exerted on the brake housing is transmitted by a lever solidly connected with the latter. This rests without any friction on a spring exposed to a pull, which is tightened by means of a handwheel and nut.

The steam consumption of the turbine was ascertained by measuring the condensed steam discharged from the surface condenser. The condenser plant comprises a surface condenser, a dry-air pump and a wet-vacuum pump. The cooling water being derived from the municipal mains, experiments on any higher loads could be carried out only by night. The absolute pressure at the discharge tube of the turbine was measured directly by means of a shortened barometer.

As the maximum steam pressure inside of the turbine, owing to the considerable pressure drop in the nozzles, does not exceed 1.84 atmospheres absolute, all the pressures could be gaged by means of mercury columns. Small tubes were connected to a three-way cock susceptible of being rotated by a handwheel which allowed of connection with the mercury mamometer. These measurements were effected in the stationary parts of the turbine at the entrance and issue of the guiding vanes.

The temperatures inside of the turbine were determined thermo-electrically by means of thermo elements which could be connected to the galvanometer by means of a switch. These thermo elements were in each case introduced into the steam current between two guiding vanes. In order to allow the condition of the steam before its entering into the turbine to be adequately gaged, the steam was superheated to about 100 degrees Centigrade above the temperature of saturation.

The maximum output of the turbine, with 9.04 atmospheres absolute before the regulating valve, normal speed, 87 degrees Centigrade superheat and 0.094 atmospheres absolute final pressure, was found to be 235 horsepower, and the steam consumption per brake horsepower per hour 15.94 pounds. This compares favorably with turbines of other make for the same output, the more so as this was the first turbine ever built of this design and accordingly was not free from defects, especially in the high-pressure stage. By increasing the speed to 3320 revolutions per minute, the output is increased to 238.5 horsepower and the specific steam consumption reduced to 15.59 pounds per hour, corresponding with a maximum efficiency of 54.4 per cent.

The pressure drop in the high-pressure portion shows this not to be a mere speed stage as would have corresponded with the constructor's intentions, an expansion taking place inside of the reversing vanes 1 and 2 and the running vanes 2 and 3, resulting in an increase in the speed of the steam. The pressure drop in those stages amounts to 0.4 of an atmosphere with full load and to 0.15 of an atmosphere with one-quarter load. It is partly due to departures in the design of that part of the turbine from the inventor's own diagram.

The behavior of pressures in the low-pressure part of the turbine shows the existence of a steam expansion both in the running and particularly in the guide vanes. There is thus no pure impulse in a manner similar to all the so-called impulse turbines. The practically absolute identity of the heat capacity before and behind the nozzles, respectively, shows that owing to the impact of the radially flowing steam jet on the thermo element, the kinetic energy is reconverted into heat.

The factor mainly responsible for the behavior of a steam turbine is its total efficiency, the more so as this, independently of the conditions of experiment, allows of an immediate comparison with turbines of other makes. According to previous data, the maximum efficiency was found to be 54.4 per cent. with a speed of 3320 revolutions per minute, while the figure corresponding to a normal speed of about 3000 and an approximately equal output is 53.4 per cent. An increase of 10 per cent. above the normal number of revolutions thus results in a slight improvement of the efficiency, the impact losses of the turbine being reduced. These results obtained in the case of the first Eyermann turbine ever constructed may be considered as extremely satisfactory.

Plans have been recently completed for the construction of a 5000-horsepower turbine of similar design, but the two-speed stages of the high-pressure part are to be arranged on the running wheel proper in front of the low-pressure stage, so that the steam will flow exclusively from the shaft toward the outer circumference of the turbine.

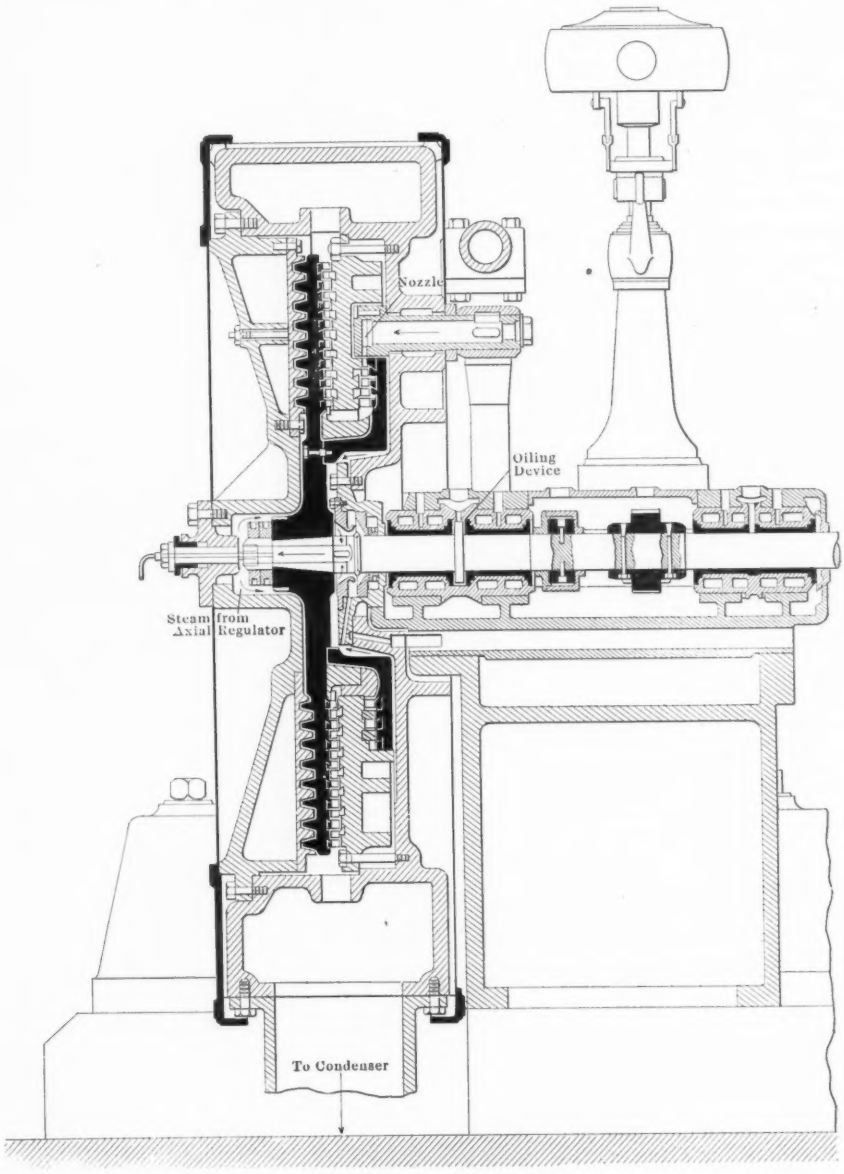


FIG. 6. VERTICAL SECTION THROUGH EXPERIMENTAL TURBINE

The Inspection of Steam Boilers

The Necessary Tools and Clothes for the Purpose; a Complete List of Questions to Guide the Inspector, Followed by Practical Instruction

BY JAMES F. HOBART

The purpose of boiler inspection is primarily to ascertain the condition of the several parts of which a steam vessel is composed in order to determine the working pressure which may be safely carried in that vessel. The inspection may be for the purpose of obtaining or carrying insurance, or it may be for the purpose of establishing a value in the case of purchase or sale of second-hand boilers. In either case, the determination is the same, viz., the physical condition of the vessel and the safe working pressure which may be carried.

The inspection of a shell in a machinery yard must necessarily be some different from the necessary inspection when a boiler is in position for actual use, because in the first case it is only necessary to determine the strength of the shell in its present condition of wear and repair, while with a boiler in a setting ready for use other things must be looked after, and in addition to the condition of the boiler itself the inspector must determine the condition and fitness of the necessary appliances for safety in the operation of a steam boiler. For instance, no matter how strong a shell, no inspector would pass a boiler with a stop valve between the boiler and the safety valve, or with the water-line glass set below the level of the top row of tubes.

A Suit for the Inspector

To inspect a boiler with a reasonable degree of comfort and unnecessary expenditure of time, certain tools and appliances should be provided. First, will be mentioned a suit or dress for the inspector. True, boilers may be inspected by a man dressed in overalls and jacket or in an American or a Filipino dress suit (the latter consisting of a four-in-hand breech clout), but inspection in such dress is not very comfortable either for the man or for the clothes, and any man who intends to do much inspecting should provide himself with the following articles of dress, also with the tools enumerated:

To properly inspect a boiler, a man must crawl; he must creep through the firebox, the back combustion chamber and into the smoke front. He must also wiggle his body into the shell above the tubes and sometimes below, consequently there is needed a dress as nearly dustproof as possible. The combination suit shown in Fig. 1 fills the bill, and a pattern of such a suit may be obtained from any tailor, who will cut it from actual measurement of the person to wear it. A suit should be made to fit the person. It should not be tight, still it must not be baggy. It should be cut to fit over the underclothes, the other garments being removed before the inspection suit is put on.

As shown in Fig. 1, the suit is open in front and buttons very tightly around the throat, a sort of standing collar or band being fitted to the neck and fastened with a single button. The sleeves and legs are made large enough to pass the hands and feet easily, and then they are drawn close to the flesh by means of four straps with patent buckles that need no hole in the strap and will fasten anywhere. The writer has tried various fastenings, elastics, straps attached to the cloth and arrangements for buttoning the garment close to ankle or wrist, but the loose strap gives the best satisfaction of any device yet tried.

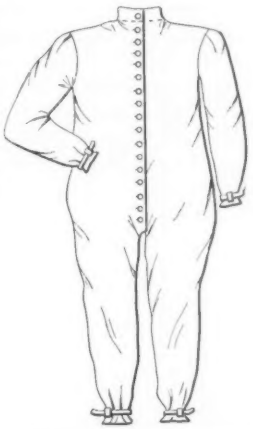


FIG. 1. COMBINATION INSPECTION SUIT

FIG. 2. HOOD AND CAPE

High shoes should be worn, and the cloth legs of the suit strapped outside of the shoes. If gloves are used, strap the sleeves outside of the gloves, but the writer prefers to have the hands bare as it is sometimes very inconvenient to have the hands covered with cloth or leather. The head should be covered with the hood shown in Fig. 2, which is fitted closely to the face across the forehead below the hair line and down the cheeks, buttoning closely under the chin. A cape, also well fitted with buttons, is attached to the collar of the hood, and when the cape is buttoned it prevents effectually any dirt from getting down the neck unless the wearer actually stands on his head under a dust spout. For a considerable time the writer carried a pair of ankle straps made to fit the legs and with short straps attached to pass under the foot, the object being to prevent the leg of the suit from being dragged off of the shoe top when it was necessary to back out of a particularly narrow passage. These straps are all right for the purpose, but they proved more bother than was necessary and were eventually discarded for the plain, loose straps noted in a preceding paragraph.

Necessary Tools

For tools, the inspector needs but few, and can get along with very simple ones. A hammer is about the only tool actually necessary, but we will fit out our inspector with all the tools he can possibly need. As the first tool any mechanic usually invests in is a tool chest, so will the inspector invest and spend some money for a dress-suit case. If much inspecting is to be done get a good one. Genuine sole leather only will stand the strain of constant use. Pack the combination inspection suit in the case, also put in a pair of stout shoes which are to be worn with the suit. It doesn't make good shoes look very well to draw them through and under a boiler or two.

Next, the hammer; the writer prefers a hatchet peen, the body being 15/16 inch square at the hammer end, and with the peen bent forward as shown in Fig. 3 at *A*. This is for the purpose of allowing that corner of the peen to be ground sharp and kept so. As soon as the metal becomes ground off so that the front edge of the hammer is straight, then have the blacksmith bend the peen a little more at *A*, so that there will always be a sharp hooked corner at that point. The value of this portion of a hammer for digging rust and corrosion out of a corner between two sheets can only be appreciated by the man who has "been there." It is even better than a cold chisel and has the advantage of always being on hand when wanted.

A cold chisel is a handy addition to the inspector's "kit," but as these tools can nearly always be obtained in any boiler house, the writer prefers to take the chance of finding a sharp one if it is needed. Some candles will be needed. At various times, torches of different types have been designed for the use of the inspector, but the paraffin candle is

the "old reliable" in boiler inspecting, and even with the most approved pattern of inspection torch, the writer would want a candle or two in his grip, "just for emergencies," you know.

A steel scale, 3 or 4 inches long and preferably graduated to hundredths of an inch. should be included in the outfit, also

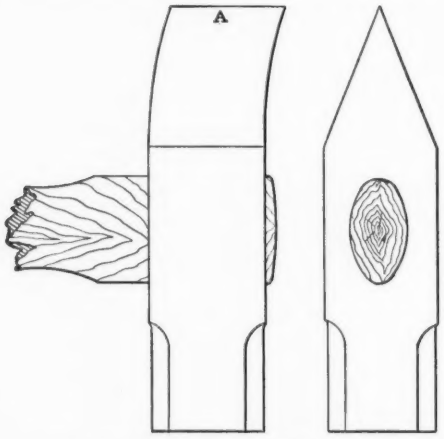


FIG. 3. BOILER INSPECTOR'S HAMMER

a pair of calipers is carried by some inspectors. If marine work is to be done, it will be necessary to add a micrometer caliper fitted for ascertaining the thickness of copper pipes. This little instrument may be purchased from most supply houses, together with the gage and pump for testing steam gages, and there should be included in the list a jack for removing the hand or pointer from a steam gage.

The micrometer pipe-thickness gage shown at *A*, Fig. 4, is made in such a manner that it may be inserted through a ⅜- or ½-inch hole, and the construction of the gage permits the pipe thickness to be taken at *C*, beyond the burr raised by the drill. If the inspector is not successful in getting hold of a micrometer gage similar to the one shown in Fig. 4, he can make a very handy tool which will aid him in measuring the thickness of pipe walls and many other pieces of metal.

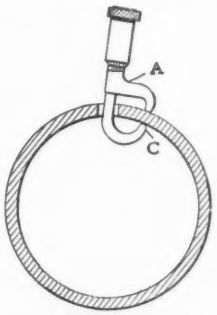


FIG. 4. MICROMETER TO MEASURE PIPE THICKNESS

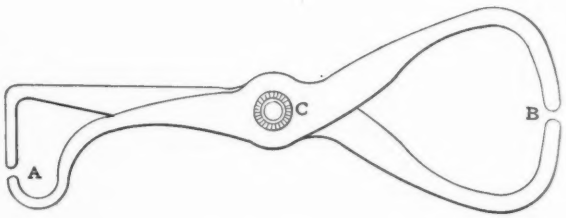


FIG. 5. HANDY HOMEMADE PIPE AND SHEET CALIPERS

This tool is shown in Fig. 5, and it is easily made from a bit of sheet steel, the necessities being the hook at *A*, so shaped that it can be placed inside a pipe as shown at *C*, Fig. 4. The other ends of the tool legs may be shaped in regular outside caliper form, as shown at *B*, Fig. 5, and it is only necessary that both *A* and *B* be made exactly the same distance from fulcrum *C*.

To use this tool, insert the hook *A* through a hole in the pipe and bring both the caliper points against the wall of the pipe, taking care to place them squarely against the metal. Then with a steel scale measure the distance between the points at *B*. This distance will be the thickness of metal between points *A C*. If an ordinary bit of plate is to have its thickness determined, close points *B* upon the plate, then measure the thickness with the scale at *A*. The pin *C* must be well fitted and carefully adjusted so as to hold the caliper legs easily yet firmly.

The exact determination of the thickness of a plate is a vital point in boiler inspection, and in case of second-hand shells which have been attacked by corrosion, it is absolutely necessary to determine the least thickness of any wasted sheet in order to calculate the pressure which may be safely carried. Therefore, in inspecting any second-hand boiler do not hesitate to drill one or more plates and determine their actual thickness, provided the thickness cannot be determined in any other convenient manner. A hole in a boiler shell is easily closed with a single rivet and that hole may mean the difference between safety and a disastrous explosion.

A master steam gage must be in the possession of the inspector, for it is very important that the actual recording condition of the steam gage be determined. In many cases the gages are found to be "fast" or "slow," meaning that the defective gage indicates more or less than the actual boiler pressure. If a steam gage indicates only 50 pounds pressure when there is 70 pounds pressure above the atmosphere in the boiler, then that gage is said to be "light" or "slow," and it is dangerous. On the other hand, when a gage indicates too much pressure it is said to be "fast" or "heavy," and is safe enough, but not a good appliance for the owner.

When the inspector tests the gage and finds it is not indicating pressure enough he changes the mechanism and adjusts it so that the gage will indicate true boiler pressure. When it is found that the gage indicates a few pounds more pressure than there actually is in the boiler, then the inspector does not always change or adjust the gage. He is satisfied to let the owner run the boiler with a few pounds less pressure than it is supposed to carry. This is the case when the inspection is for insurance.

The master gage should be kept for the sole purpose of comparison with other gages, and should in turn be sent to the manufacturer at least once (better twice) each year for comparison with a mercury column. The inspector must have means of comparing gages with the master gage he carries, and the usual instrument for this purpose is a screw pump which is easily carried in the inspector's suit case. Pumps of this kind are carried by supply houses and are offered in a variety of styles, some—the usual kind—being filled with water after the gages have been attached, as shown by Fig. 6, and pressure being obtained by screwing in the plunger. The master gage is shown at *B*, the gage to be tested being placed at *C* and both connected to the test pump *A*. By screwing in the screw attached to the handwheel *D*, any desired pressure within the limits of the pump may be put upon both the gages. From 100 to 500 pounds

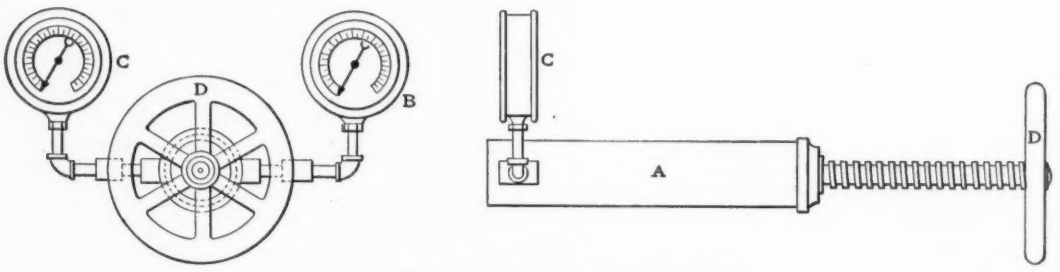


FIG. 6. MASTER GAGE AND TEST PUMP

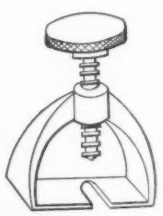


FIG. 7. JACK FOR PULLING OFF GAGE HAND

is easily worked up with one of these pumps if it is in good condition, as there are no valves, and the pressure is held directly by the screw piston and its leather-cupped packing.

There are many styles of gage-testing pump to be obtained in the market. One kind in particular is well fitted for inspection purposes as it does not weigh over one pound and uses no water. It is operated by compressed air in the ½-inch barrel of the pump, a small, hand-operated plunger similar to that of a bicycle pump doing the compressing. Pressures of 400 to 500 pounds may be easily worked up on one of these pumps. The gages are compared on falling pressure by opening a little valve which permits the air to escape slowly from the barrel and the gages.

If gages must be tested and no pump is at hand, they may be connected up and the necessary pressure obtained with a common bicycle pump. The air pump from a gasolene blow torch, such as is used by plumbers, has more than once done duty for testing gages when no regular pump was at hand. The boiler-feed pump may also be utilized for gage testing. With both gages connected to the pump, either steam or belted, the necessary pressure may be worked up and down, as required for a proper comparison of the gages.

Several times the writer has desired to compare gages when absolutely nothing in the shape of a pump could be obtained, but the trick was turned by connecting both gages to a short bit of heavy lead pipe less than a foot long. The pipe was filled quite full of water, the gages screwed tightly on and then the pipe was squeezed in an iron bench vise until the required pressure was obtained. If no lead pipe is at hand, use a bit of iron pipe 2 or 3 feet long and fill with water. Then heat the pipe carefully (a forge fire will do and so will a gasolene torch) until the required pressure has been obtained. In this method great care must be taken that the pressure does not run up too high and damage the gage. A turn or two in unscrewing one of the gages will relieve the pressure if it starts to run too high.

While the inspector is giving attention to the gage, he will see that the piping is so arranged that there is a water seal or trap below the gage and arranged in such a manner that steam cannot get into the spring or tube of the gage. High-temperature steam will temporarily cause the gage to indicate wrongly, and the derangement is frequently made permanent through the spring taking a "set" when heated to 350 degrees or more. The ordinary "goose neck" forms an effectual barrier to live steam, and an inverted siphon, formed by the piping below the gage, also serves the purpose effectually. The inspector will also see that the gage, if exposed to possible freezing, is fitted with means for draining the pipe when the boiler may be closed down.

One more gage tool is necessary, and that, together with a pair of small pliers and a little screwdriver, completes the outfit of the inspector. The tool in question is a "jack" for removing the hand or pointer from the shaft of a gage. One form of jack is represented by Fig. 7. This tool is slipped over one end of the hand or pointer, the notch brought under the hub of the hand, then the end of the screw is brought down against the end of the shaft and a few turns of the screw forces the hand loose without danger of bending either hand or shaft, as is often done when the hand is pulled off with a pair of pliers.

Thus far, the following articles are supposed to have been acquired by the inspector: One 24-inch dress-suit case of solid sole leather, one union inspection suit and one hood with cape (two necessary for steady work), one pair of shoes, four straps, one towel, one cake of soap, one clothes brush, hair brush and comb, six paraffin candles ("sixes"), box of matches, one hatchet-peen inspection hammer, one master steam gage, one test pump, assorted fittings for attaching various gages, gage jack, one small screwdriver, one small pair of pliers, one pair of gloves (if you use them), pencils and pad of paper.

Furthermore, if the inspector is to work at a distance from home, it is well to add a dust-tight rubber bag in which may be carried a nightshirt or pajamas, a clean collar or two and perhaps a clean shirt and a few handkerchiefs. But it is of no use to try to carry these things in the inspection case unless they are tightly inclosed in a rubber-cloth bag, and well tied up at that, for the dust, which will quickly permeate every portion of the inspection suit and the case, will penetrate the clean clothes unless they are protected.

Preliminaries to Boiler Inspection

Having arrived at the place of inspection, the first thing to be done is to see that the boiler is in proper condition for inspection. It is the duty of those in charge to have the shell ready for the inspector, but this duty is frequently neglected. Before putting on his inspection dress, the inspector should look over as much of the boiler and its setting as he can see without getting dirty. Note if the combustion chambers have been cleaned out and the shell of the boiler swept clean. Note if the boiler has been opened and the interior surface washed clean and the dirt removed as far as possible.

It is a difficult job to inspect a boiler which is so coated with dirt that the inspector cannot get at the shell without digging and scraping down to the shell at every point where he wishes to investigate. It may, indeed, be possible to inspect a boiler in that condition, but the experienced inspector soon learns to see if the boiler has been properly prepared for his work and to promptly shy at a dirty, unprepared boiler, cordially inviting the owner then and there to put the boiler and setting in shape for inspection. If the inspector has to wait for the boiler to be cleaned, he can be testing the gages and inspecting the external conditions meanwhile; including the boiler setting, the piping, the safety valve and the numerous points of possible danger during the operation of a steam boiler.

The blowoff in particular should receive very close attention. If possible, the end of the blowoff pipe should be in plain view, so that if the blowoff valve leaks the fact will be at once apparent. Blowoff pipes terminating in a sewer or beneath the floor level where the discharge end of the pipe cannot be seen, are dangerous and should be vigorously combatted by the inspector. If it is not possible to have the end of the blowoff pipe in view of the engineer, then cut the pipe at some point where it can be plainly seen, put in a pair of bolted flanges and arrange them so they will fall apart sufficiently, upon removal of the bolts, to permit a sheet of tin or brass to be placed between and left there until the boiler is to be blown down again. Any leakage in the blowoff valve will become visible as the water runs down over the sheet of metal between the flanges. When blowing is necessary, it is the work of only a few seconds to pull out the sheet metal, insert a couple of bolts and screw them up with the fingers. Then the blowing off can be done, after which the sheet iron must be replaced immediately, under penalty of instant dismissal of the attendant if the metal is ever found removed from the pipe except when blowing off the boiler.

Questions Covering Inspection

For the purpose of determining the safety of a steam boiler when operated under a given pressure, or to determine the working pressure which a given boiler is good for, the inspector is chiefly concerned with the diameter of the shell, thickness of plates, efficiency of the joint in the longitudinal seams and the bracing of the heads, together with the condition of the tubes as regards their holding power. For instance, when the tube ends have wasted away until they are very thin, the head-holding power of the tubes has decreased—how much, or to what extent, the inspector must make it his business to determine. Usually the safe holding power of a tube is taken as one-seventh of its tensile strength. But to make a report upon a boiler for the basing of insurance, other things have to be taken into consideration, and in order to have full data at hand the inspector should prepare himself with a blank for each boiler with the following numbered questions printed or written upon each. When the answers of these questions have been

found by inspection and entered upon the blank, then data are at hand for deciding each and any question concerning the boiler, which can be asked for insurance purposes or for purchase or sale. The questions are as follows:

1—What type of boiler?
2—Length? Diameter?
3—Plate thickness of shell? Of heads?
4—Thinnest place found on shell? On heads?
5—What stamps are found on shell? On heads?
6—Name of boiler maker?
7—Date of making of boiler?
8—Nominal diameter of tubes?
9—Present outside diameter of tubes?
10—Present inside diameter of tubes?
11—Present thickness of tube ends?
12—Riveting of longitudinal seams, single? Double? Triple? Butt strap?
13—Calculated efficiency of joint?
14—Present efficiency of joint?
15—What is the external condition of shell?
16—What is the external condition of heads?
17—Are there any corroded plates, joints or rivets? Describe the extent, character and location of each.
18—Did you find any leaky seams? Leaky rivets?
19—Are any of the tubes leaking? Plugged?
20—Are there any signs of leakage or distress at any of the pipe openings?
21—If a half-arch front, is the dry sheet burned to any extent?
22—If so, how much?
23—Are there any bulges, bagged spots, blisters or signs of distress in or on any of the fire sheets?
24—If so, give location and description of each.
25—Give percentage of plate-section reduction caused by such defects.
26—Are all pipe openings into boiler fitted with adequate pads or flanges?
27—State thickness, size and fastenings of each.
28—Is blowoff pipe wasted or burned? If so, how much?
29—Are manholes and handholes properly reinforced?
30—State type of manhole used and whether pressed or cast steel?
31—Is back arch in good condition?
32—Give hight of arch at boiler above top row of tubes.
33—How is boiler supported?
34—How far above or below top row of tubes do side walls touch shell?
35—Is top of boiler covered?
36—If covered with brick, does the weight thereof rest upon the shell?
37—Is boiler fitted with three gage cocks?
38—Give hight of lower gage cock above top side of top row of tubes.
39—Give hight of lower end of water-line glass above or below top of tubes.
40—How is steam gage attached to boiler? By direct pipe?
41—Is gage properly connected to boiler through goose neck or invert?
42—Is steam gage correct? Did you test it?
43—If steam gage is not correct at all readings, state variation.
44—What type and make of safety valve is attached to boiler? State size.
45—How is safety valve attached to boiler?
46—Is there a stop valve between safety valve and boiler?
47—If safety valve is not connected direct to a special opening in the boiler, then give full description and sketch of its connection.
48—Is main steam pipe properly supported adjacent to boiler?
49—Is pipe so arranged that expansion cannot affect its connection with the boiler or cause undue strains either to the pipe itself, to the boiler or to any of the pipe connections or lengths?
50—Is expansion of boiler shell carried to the rear by the proper action of rollers under rear-end lugs?
51—Are there any signs of distress to pipes or setting as if caused by improper movement of boiler to the front through expansion?
52—Does water flow upon any portion of the boiler shell, either periodically, constantly or occasionally from rain, leaky pipes or any other source?
53—If water thus reaches the shell, state where it reaches the shell and what damage has been done to setting if any, and what corrosive effect it has had upon the shell.
54—Where does blowoff leave the boiler?
55—Where does the feed pipe enter the shell? Is a feed-water heater used?
56—What internal feed-pipe connections are there?
57—Where is the feed water discharged into the boiler?
58—Does the feed water impinge directly against either shell or tubes?
59—If horizontal-tubular boiler, how many braces in front end above the tubes? How many braces below tubes?
60—How many braces above tubes in rear end? How many below tubes?
61—How many through braces or stays? Give thread-section diameter.
62—What is the length of the shortest brace in the boiler?
63—What type of brace is used?
64—How are the braces attached to the heads? Is the method satisfactory?
65—Are the braces sufficient in number?
66—Are the braces properly distributed over the head surface?
67—Are any of the braces loose, cracked or broken?
68—Do any of the braces appear unduly tight when struck by the hammer?
69—Is there any wasting away of the rivets or other portion of the attachment of the braces to the heads?
70—Is there any deposit of oil, mud, scale or other substance on heads?
71—Is there any pitting, grooving or other corrosion on the heads?
72—Is there any wasting away of the heads adjacent to braces, tubes or shell plates?
73—If there be such wasting of the head, what is its percentage of plate thickness?
74—Is there any deposit of scale on heads, tubes or shell plates?
75—If there is a scale deposit, describe its thickness, character and general appearance, whether hard, loose, or adhering tightly.
76—Describe all indications of corrosion of tubes or shell plates and carefully note all indications of wasting or other reduction of plate thickness and give the percentage amount of such thickness reduction.
77—Describe all indication of wasting of rivets in shell seams?
78—Are there any broken or loose rivets? Locate and describe all such.
79—Are there any deposits of mud, loose scale or other substances?
80—If such deposits are found, locate and describe them.
81—Did you find any indications of burning or overheating in the shell plates or in the rear head or tube ends?

The inspector who has searched for and found the answers to these questions should know enough about a boiler to determine intelligently its safe working pressure with the given factor of safety, which should never be less than five. Some Government inspection rules permit boilers to be operated with a slightly lower factor of safety, but no man will go wrong by insisting upon five as a factor of safety in all steam vessels.

Engineers' Society of Milwaukee

Wisconsin has taken a very high rank for preserving forest reserves and looking after its forestry and streams with a view to the future. Acknowledgment of this prominence was given the State at the conference of governors, called by President Roosevelt last spring.

At the monthly meeting of the Milwaukee society of engineers, held on Wednesday evening, November 11, State Forester E. M. Griffith delivered a lecture, illustrated with lantern slides, upon "The Close Relation Between the Forest Reserves and the Water Powers of Wisconsin." The lecturer, after discussing the general subject of forestry and reforestation, in their national State aspects, treated especially of the influence of forests in the regulation of stream flow, storage reservoirs and water powers of Wisconsin.

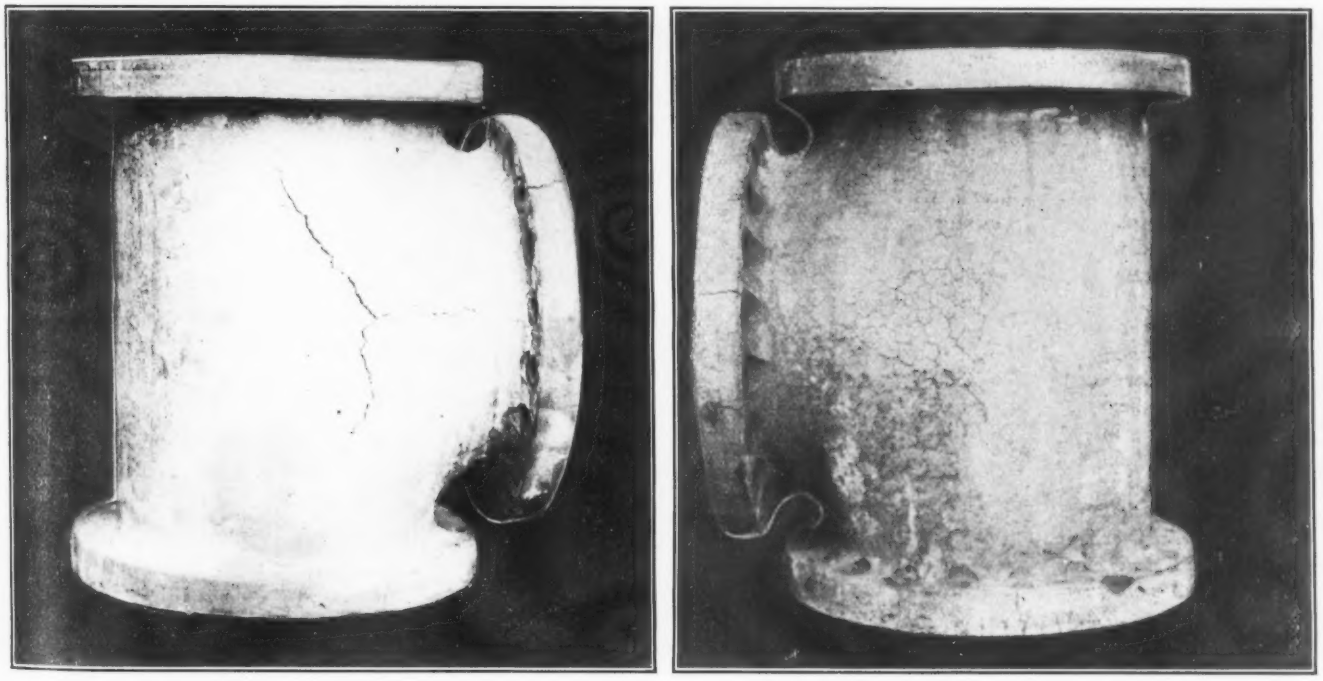
The number of gallons in a cylindrical tank $= D_2 \times L$ (both in inches) $\times$ 0.0034.

Effect of Superheated Steam on Cast Iron Fittings

The accompanying engravings are reproduced from photographs of a 20-inch cast-iron tee taken from the main steam line of the Pratt street power house of the United Railroads, of Baltimore, Md., after exposure for some three years to steam of 160 pounds pressure and superheat at 125 degrees, making the ultimate temperature something less than 500 degrees Fahrenheit. The left-hand view shows cracks which open about ⅛ inch on the outside and which leak steam. The other view shows fine hair cracks; the inside surface is covered with a hard, reddish oxide, with no cracks visible. The casting is nearly ¾ inch longer and 1 inch larger in diameter than when it was put into the main.

Reforestation Benefits Water Power

The beneficial effect of reforestation on water power is vividly illustrated in the case of Miller's river, Massachusetts. A number of concerns, including the L. S. Starrett Company and the Union Twist Drill Company, of Athol, Mass., have power derived from this river, and both concerns have auxiliary steam power to help out during the dry season. A few years ago the water would fail almost entirely in July and August, requiring the maximum capacity of the steam plants to run the works, but during the last two or three years the volume of flow has been almost equal to the normal demand for power during the whole summer, and the steam power has been required for a minimum period. The reforestation of the uplands of the drainage area that has been going on rapidly during the last twenty or twenty-five years has restored the old conditions, and now the rainfall is held back by the trees, shrubbery, leaves and moss, the whole acting like a huge sponge to absorb and feed out the water instead of precipitating it at once into the water courses. In our generation it is common experience that water power, except on large rivers, is very uncertain and unreliable, but with reforestation of the upland areas we may see our streams in a few years restored to the equable flow all the year round that existed in the days of the early settlers. The benefit of conserving forests on the uplands and replanting lumber areas cannot be overestimated from almost any point of view.—*Machinery.*



EFFECT OF SUPERHEATED STEAM ON CAST-IRON FITTINGS

Engine Regulation

By F. L. Johnson

After lighting the cigar I gave him, and reflectively studying the band, my young friend said:

"I used to see a great deal in the papers about some sort of a retarding device connected with the governor of an engine preventing immediate action of the governor and conducing to the closer speed regulation required when running generators directly connected to engines in parallel. I have never understood why delaying for the fraction of a second, even, the action of the governor would make an engine run steadier, and thus synchronize with another engine with its governor also hobbled, better than when both governors were free to act the instant action was needed. The explanations that have been made to me are as 'clear as mud' and only leave me in greater ignorance than before, for it always makes me think that there is one more man in the world who does not know what he is talking about.

"I saw this governor-retarding business tried out to my satisfaction one day not a great while ago. The occurrence was purely accidental, but I indulged in many a quiet smile since, as the thought of it has returned to me. It happened thusly:

"A central station had been changed from belted units of all sorts to direct-connected generators of the 60-cycle three-phase type, and the task of synchronizing was to be performed by an expert from the factory where the generators were built. The belt wheels and shafts of the engines had been replaced with new shafts of larger diameter with the field and flywheel all in one and the speed changed from 75 to 100 revolutions per minute. The engineer in charge of the plant had attended to the change and the engines were ready for the first run.

"The expert's first act was to inquire as to the character of the oil in the dashpots attached to the governors. When informed that they were empty, he directed that they be filled with the heaviest cylinder oil obtainable. An oiler was sent to attend to the matter, and to facilitate filling the oil pots he disconnected the plungers from the governor. One engine, which had been installed with the new style of generator some time before, was running, and it was desired to synchronize the other two which had been rebuilt with it. The dashpots being filled with the heavy oil, the first engine was

started. When the proper speed was reached, the switch which coupled the generators together was thrown. Everything worked perfectly and by means of a sliding weight attached to the cross shaft of the governor, controlled from the switchboard, the greater part of the load was shifted back and forth from one generator to the other. The synchronism and the speed regulation were 'all to the good' and the engines kept in step like soldiers passing in review.

"After about half an hour of exercise and showing of paces, the second engine was started and cut in on the line. This engine, too, behaved just like the other, and with all three of the engines running the load was distributed in all sorts of ways between them. The synchronism was perfect under all conditions and it was certain that no ordinary change of load would throw the engines out of step. The expert and his assistants complimented the engineer upon the thoroughness of his work and the ease with which the synchronizing was accomplished.

"Attention was called to the perfect control of speed, due, as was claimed, to the fact that the governors had been prevented from too hasty action by the restraining influence of the cylinder oil in the dashpots. This claim looked good on the outside until it was discovered that after the dashpots had been filled with the heavy oil, the oiler who had filled them forgot to attach the plungers to the governor. This discovery upset everything, and the expert, thinking that there was a conspiracy on foot to play a trick on him, left the plant with a mixture of haste, dignity and wrath.

"The point that was most forcibly impressed upon my mind was that it is usually a pretty good plan to give an engine a fair chance to show what it can do before handicapping it with hobbled governors and other left-handed improvements devised by men of very limited experience and observation in steam-engine operation.

"The engineer had the cylinder oil in the dashpots replaced by kerosene, and the last time I saw him he told me that all the engines were running satisfactorily with kerosene in the dashpots.

"It has always seemed to me that engines with alternating generators run well in parallel not because of retarding devices attached to the governors, but in spite of them. It seems that with two generators once in step it requires considerable irregularity in the speed of one unit to get it out of step. I remember one instance like this:

"The switchboard attendant complained to the engineer in a languid sort of a way that No. 1 engine was making a little trouble with the current. At that time three other engines and two turbines were all running in parallel. Going to the engine named, the engineer saw that the steam valve on the head end of the high-pressure cylinder was not picking up. The drop rod to the dashpot was too short, and the high-pressure cylinder was running one-sided. This, of course, tended to cause irregularity of speed in this engine and to throw it out of step with the rest, but the impulse was not strong enough and the current from the other machines held it in the line. It took only a few seconds to lengthen the rod, and disturbance ceased at once.

"I may be—in fact, I presume I am—more than ordinarily thick, for it will take me a long time to understand the necessity for hampering and hindering the action of a steam-engine governor for any purpose whatever.

"There is a whole lot more that I am going to tell you sometime. I am now on my way to Denver to attend the convention, but I will stop in on my way home and make you a short visit."

Saying which, he re-lighted his cigar, shook hands with me and went on his way.

The Engineering Society of the Stevens Institute of Technology, of Hoboken, N. J., has issued an attractive "program of activities" for the season 1908-09, which includes general and special lectures and inspection trips, and sets forth the "clearing-house" feature of the Engineering Society Employment Bureau. E. Nyland is president of the society and E. MacN. Searle, secretary.

Estimation of Horsepower

By G. A. Glick

The uses of the curves with this article are to make possible the estimation of the horsepower of an engine with as little computation as possible. The curves of Fig. 1 are more or less dependent on the other, and were copied from Kent to make possible an approximation of the mean effective pressure, if such value was not obtained with an indicator. The values in Fig. 1 are only approximate, for the diagram does not take into consideration compression and clearance.

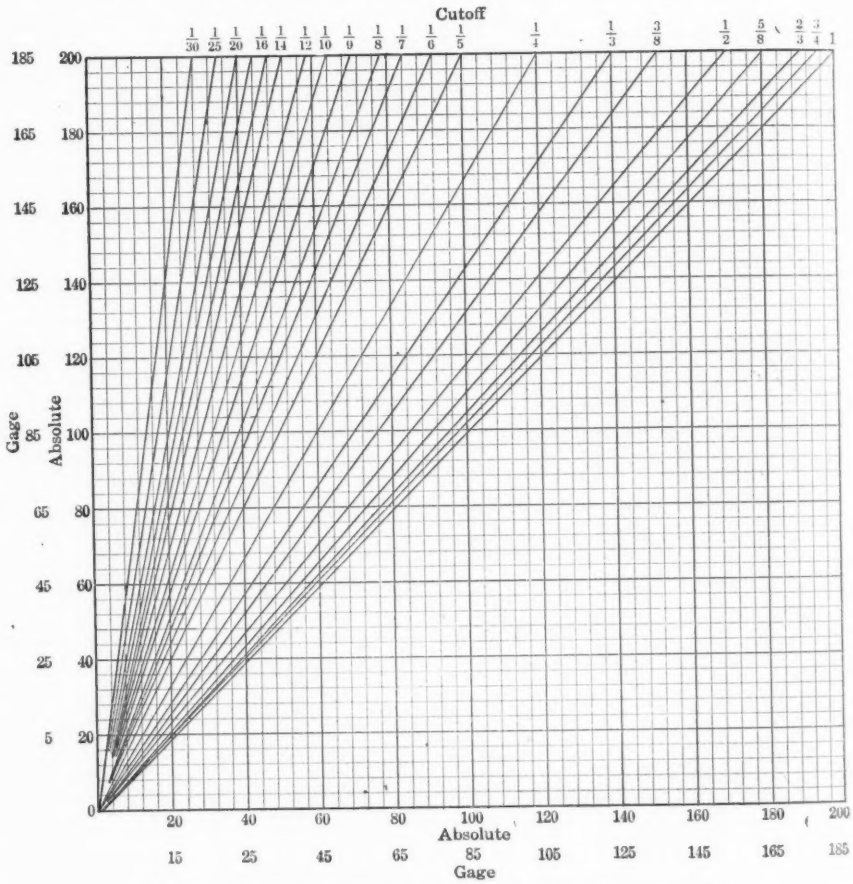


FIG. 1. CURVES TO APPROXIMATE MEAN EFFECTIVE PRESSURE

Fig. 2 is a graphical solution of

$$I.H.P. = \frac{P\,L\,A\,N}{12 \times 33{,}000},$$

where

P = Pressure in square inches,
L = Length of stroke in inches,
A = Area of piston in square inches, and
N = Strokes or twice the number of revolutions per minute.

The values of the curve are limited to: P = mean effective pressure of 100 pounds per square inch, L = 45 inches, A = 650 square inches, and N = twice the number of revolutions, or 300. The use of the curve is best explained by an example.

Suppose we had a 10x14-inch engine running at 150 revolutions per minute, which was found with an indicator to have a mean effective pressure of 60 pounds. A 10-inch cylinder has an area of πr^2, or $\pi \times 5^2 = 78.5$ square inches. Find 78.5 square inches on piston area and see where it will intersect the line for 14 inches stroke; now go over horizontally to 60 pounds mean effective pressure, and then down to 150 revolutions per minute. The horsepower can now be found by reading directly across to the horsepower line, and in this case is about 50 horsepower. Calculation shows the horsepower from the above formula to be

$$H.P. = \frac{60 \times 14 \times 78.5 \times 150.2}{12 \times 33{,}000} = 49.9$$

This result is rather closer than usual, but the reason is that the case chosen happened to be an even horsepower. If the engine had not been indicated, reference to Fig. 1 would have given an approximate mean effective pressure.

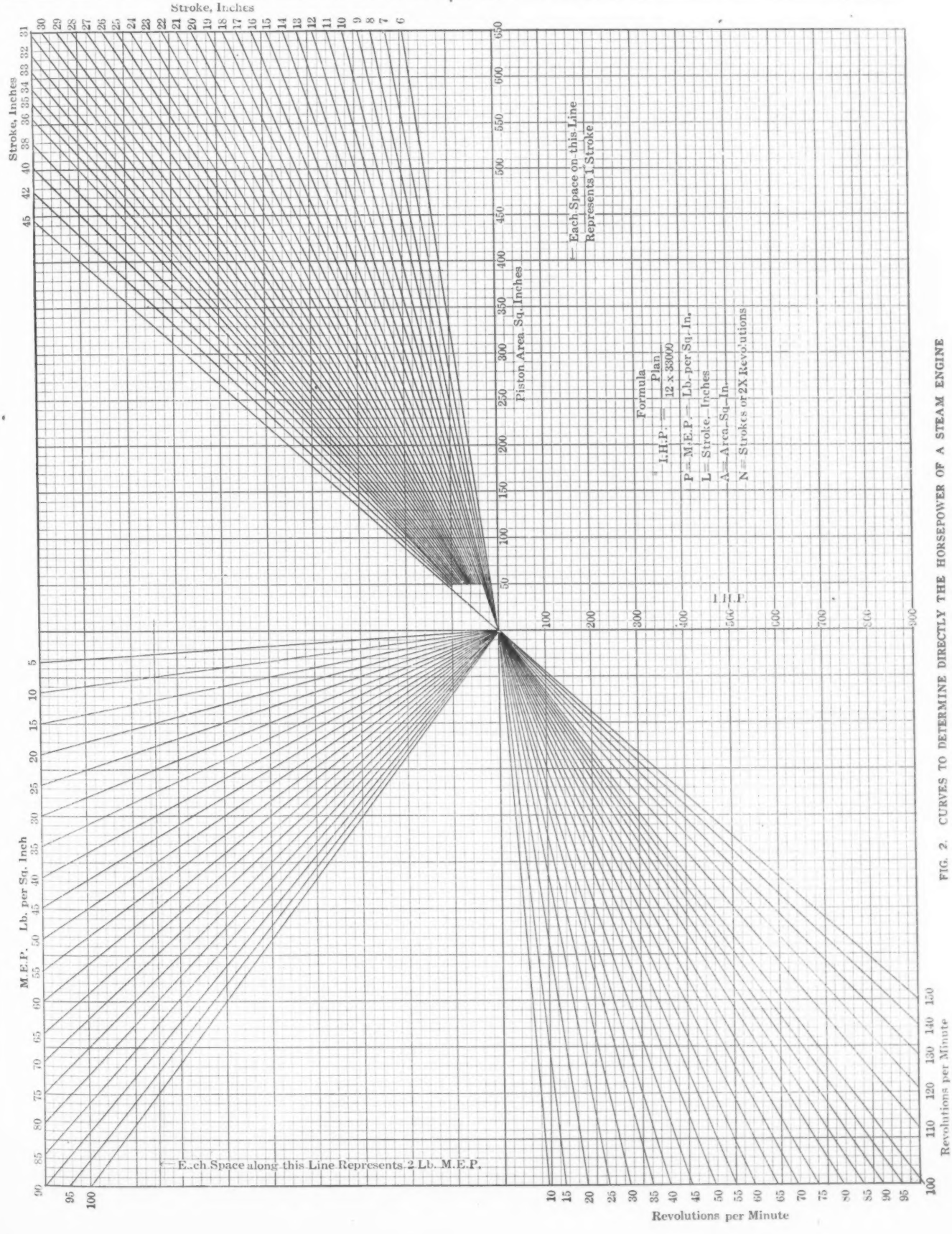

Stroke, Inches
Stroke, Inches
Each Space on this Line Represents 1 Stroke
Piston Area, Sq. Inches
Formula
I.H.P. = M.E.P. × L × A × N / Plan
Plan
12 x 33000
P = M.E.P. = Lb. per Sq. In.
L = Stroke, Inches
A = Area, Sq. In.
N = Strokes or 2X Revolutions
I.H.P.
M.E.P. Lb. per Sq. Inch
Each Space along this Line Represents 2 Lb. M.E.P.
Revolutions per Minute
Revolutions per Minute

FIG. 2. CURVES TO DETERMINE DIRECTLY THE HORSEPOWER OF A STEAM ENGINE

Influence of Strap on Lap Boiler Seams

Government Tests on Single-riveted Lap Joints Reinforced with a Single Strap Show that Strap Must Always Add Some Strength to Joint

BY S. F. JETER

In 1882 the United States Government made on the testing machine at Watertown a large number of tests on riveted joints; practically all of the tests were on the single- and double-riveted lap form of joint. Both steel and iron plate were used in combination with steel and iron rivets. In addition to the lap-joint tests, there were included in this series eight tests of single-riveted lap joints reinforced with a single strap, the metal being of the same material as for the simple lap joint. Fig. 1 illustrates the methods of joint failure and Table 1 gives all of the dimensions of the eight joints tested. It will be noted that the pitch of the rivets is the same in every case, as was also the thickness of the plate; the diameters of the rivets, however, as well as the thickness of the straps and kind of material in both, were varied. The entire series of tests made by the Government on lap joints at this time was apparently for the purpose of determining the effect of varying the proportions of the joints, and to eliminate as far as possible differences that would be introduced by variations in the quality of the sheets and rivets. All of the iron plate used was purchased of one manufacturer and of the same grade; all of the steel plate used was made of metal from one heat, cast into ingots of the same size, the only difference in the sheets being the thickness to which they were rolled. All of the iron rivets used were of one quality, "Burdens Best," and the steel rivets were made of metal of about the same quality as the sheets.

On account of the care exercised to obtain materials of uniform quality, these tests of the reinforced joints are particularly interesting to those who are concerned with the question of whether or not the reinforcing strap, as applied to lap joints, is effective. Since all of the tests on the simple lap joints were made on sheets and rivets of the same quality as those used in the tests of the reinforced seams, the results obtained in these lap-joint tests can be used to throw light on the results of the tests of the reinforced seams.

Preliminary Tests

Before the regular joint tests were commenced a number of preliminary tensile tests were made on both the iron and steel plate, the test strips being 1½ inches wide and of the usual form. On fifteen of these tests on iron plate the average tensile strength was found to be 47,500 pounds per square inch, the minimum test showing 43,400 and the maximum 51,600 pounds per square inch. In seventeen tests of the steel plate the average tensile strength was found to be 55,200 pounds per square inch with a minimum of 52,042 and a maximum of 58,360 pounds. There were eighteen tests made on the steel plate, but one was so radically different from the others that it was deemed best to omit it in obtaining the average; this omitted test showed a tensile strength of 74,400 pounds per square inch.

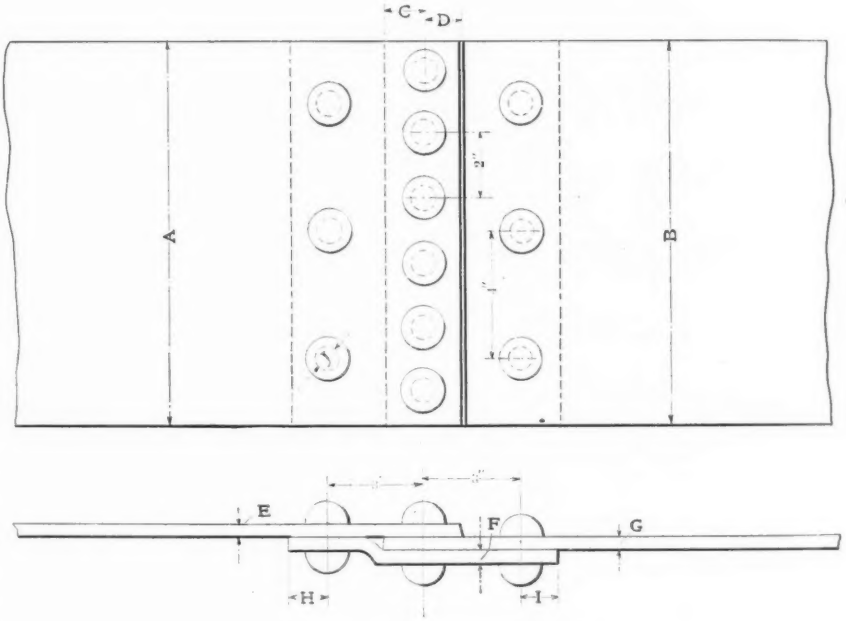


DIAGRAM TO ACCOMPANY TABLE I

TABLE 1. TESTS MADE BY U. S. GOVERNMENT AT WATERTOWN, 1882, ON REINFORCED LAP JOINTS.

	Linear Measurements.													Areas.				
Test No.	A	B	C	D	E	F	G	H	I	J	Kind of Plate.	Kind of Strap.	Kind of Rivet.	Breaking Load.	Solid Plate.	Outer Net Section.	Shear.	Crushing.	Inner Net Section.
244	12.00	12.00	1.25	1.25	0.380	¾	0.392	1⅜	1¼	0.72	Iron	Iron	Iron	147,700	4.56	3.74	3.66	2.50	2.92
245	12.00	12.00	1.20	1.05	0.391	¾	0.391	1.8	1.25	0.82	Iron	Iron	Iron	163,700	4.69	3.74	4.75	2.89	2.79
246	11.98	11.98	1.12	1.00	0.371	¾	0.362	1.55	1.40	0.94	Steel	Steel	Steel	206,000	4.34	3.32	6.25	3.06	2.30
247	11.98	11.98	1.12	1.05	0.368	¾	0.374	1⅜	1⅜	0.94	Steel	Steel	Steel	211,900	4.41	3.37	6.25	3.11	2.33
296	11.97	11.99	1.12	1.05	0.377	¼	0.383	1.2	1.2	0.82	Iron	Iron	Iron	161,000	4.51	3.59	4.75	2.47	2.67
297	12.02	12.02	1.15	1.00	0.370	¼	0.382	1.26	1.26	0.82	Iron	Iron	Iron	151,100	4.45	3.54	4.75	2.44	2.63
298	11.95	12.04	1.15	1.00	0.376	¼	0.371	1.12	1.12	0.93	Steel	Steel	Iron	209,300	4.47	3.43	6.11	2.79	2.39
299	11.93	12.01	1.12	1.10	0.368	¼	0.373	1.12	1.12	0.93	Steel	Steel	Iron	212,300	4.39	3.36	6.11	2.74	2.32

Shearing Strength of Iron and Steel Rivets

For the purpose of obtaining the shearing strength of the iron and steel rivets used, and also to gain information regarding the strength of the metal in the net section of plates between the rivet holes, as compared with the strength shown by the preliminary tensile tests, seventy tests of lap joints were selected in which fail-

ure occurred by either breaking the net section or shearing the rivets. In sixteen of these tests in which the rivets were sheared, iron rivets were used and the average shearing strength was found to be 38,645 pounds per square inch. The iron rivets were very uniform in their resistance to shearing, the maximum noted being 44,204, while the minimum was 36,050 pounds per square inch. In eight tests in which steel rivets were sheared, the average shearing strength was found to be 56,896 pounds per square inch. The steel rivets were not nearly so uniform in this respect as those of iron, the maximum strength noted being 83,000 pounds and the minimum 43,490 pounds per square inch. As far as can be noted by examining all the tests for effects of compressive load on the rivets, none of the joint failures was influenced by such stresses. The maximum compressive load on rivets in all tests which failed by shearing the rivets was 89,580 pounds per square inch, with two exceptions, and the average was 70,071 pounds per square inch.

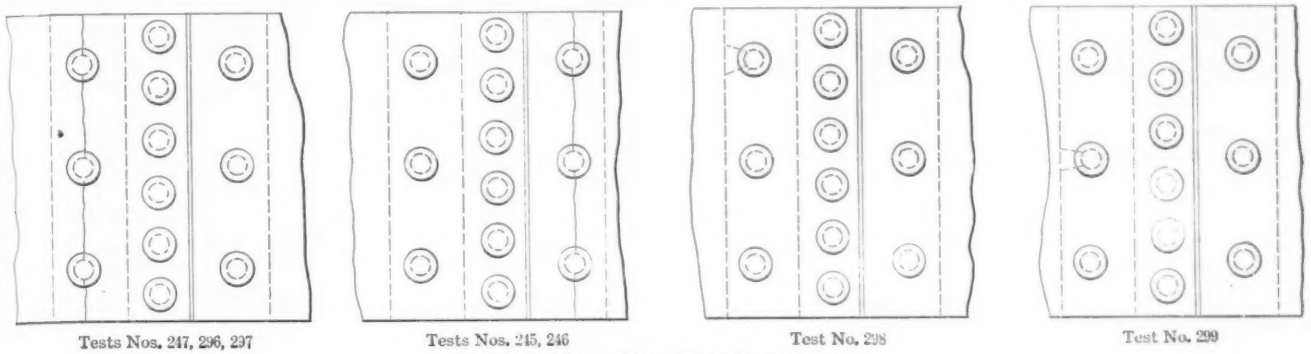


FIG. 1. METHODS OF JOINT FAILURE

TABLE 2. RESULTS OF TESTS VERSUS CALCULATED VALUES.

Number of Test.	Calculated strength of outer net section assuming T.S. same as shown by the preliminary tests.	Calculated strength of outer net section assuming T.S. same as shown in tests of lap joints.	Tested strength of net section.	Calculated strength of inner net section plus shearing strength of outer rivets.	Calculated shearing strength of nine rivets.	Tested shearing strength of nine rivets.	Calculated strength of solid plate assuming T.S. same as preliminary test.	Calculated Eff., T.S. same as shown by preliminary test.	Calculated Eff., T.S. same as shown by lap joint tests	Tested Eff., outer net section T.S. solid plate like Col. 7.	Calculated Eff., T.S., Col. 7, s. s. 38,650 lb. per sq.in.	Tested Eff., T.S. of solid plate as per Col. 7.
	1	2	3	4	5	6	7	8	9	10	11	12
244	177,600	...	...	185,750	144,600	147,700	216,500	...	...	...	66.8	68.2
245	177,600	166,500	163,700	193,700	183,600	...	222,800	79.7	74.8	73.6	...	...
246	183,200	199,000	206,000	245,500	355,300	...	239,500	76.5	83.1	86.1	...	...
247	186,000	201,900	211,900	247,100	355,300	...	243,200	76.4	83.0	86.1	...	...
296	170,500	159,800	161,000	188,000	183,600	...	214,200	79.6	74.6	75.2	...	...
297	168,200	157,600	151,100	186,200	183,600	...	211,300	79.5	74.6	71.5	...	...
298	189,400	205,500	...	210,750	236,200	209,300	246,700	76.8	83.0	...	...	84.8
299	185,500	201,200	...	207,300	236,200	212,300	242,300	76.7	83.0	...	...	87.6

Average Tensile Strength of Sheets and Net Section between Rivets

In ascertaining how the tensile strength of the sheets, as shown by the preliminary tests, compared with the tensile strength of the net section between the rivet holes, as shown by the joint tests, 25 of these tests in which iron plate was broken in the net section were averaged and the strength shown was found to be 44,541 pounds per square inch, or nearly 3000 pounds per square inch less than the strength indicated by the preliminary tests. Making the comparison with the steel plate, 21 tests showed the metal of the net section to have an average tensile strength of 59,911 pounds per square inch, or 4711 pounds greater than shown by the preliminary tests on the steel plate.

Tests of Reinforced Joints

Table 1 gives all the data relative to the eight tests of the reinforced joints, the usual type of bent reinforcing strap being used on all of the joints. Under the head of areas in the table is given the area of the solid plate on the side which broke in the test, or the area of the smallest plate where rivets were sheared. The area of net section at the outer row of rivets is given in the same manner. The area exposed to shearing strain is given for nine rivets, since it would require that this number be sheared to permit joint failure in this manner. The crushing area is likewise for nine rivets, but the influence of the crushing load is not consid-

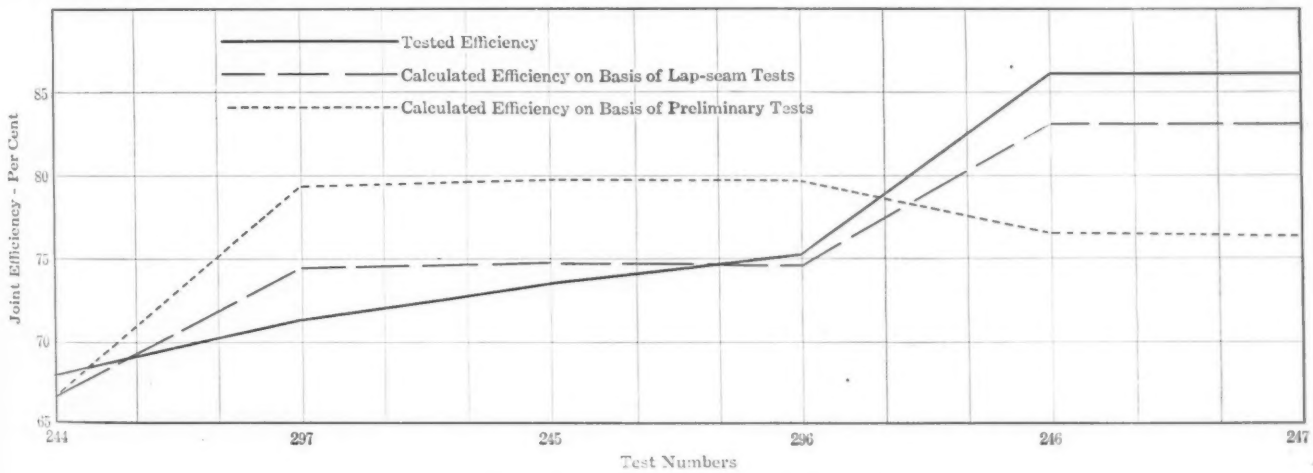


FIG. 2. EFFICIENCIES AS TESTED AND CALCULATED

ered in the following calculations, since it was evidently too low to be of importance. The four views in Fig. 1 illustrate how each of the joints failed under test, with the exception of No. 244, which failed by shearing the rivets. Nos. 298 and 299 sheared eight rivets and pulled out a section of the strap in front of the ninth rivet, as indicated. The calculations relative to these last two tests were, however, made as if all nine rivets had sheared, for it is safe to assume that the ninth rivet was very near the shearing point when failure occurred.

The Logical Method of Calculating Joint Efficiency

Table 2 gives the results of the tests and the calculations as explained below. First, assuming the shearing strength to be 56,900 and 38,650 pounds per square inch for steel and iron rivets, respectively, as shown by the lap-joint tests, and using the tensile strengths for plate as shown by the preliminary tests, viz., 55,200 for steel and 47,500 for iron, and calculating the efficiencies of the various joints, the results would be as shown in columns Nos. 8 and 11, while the tested efficiencies would be as indicated in columns Nos. 10 and 12. Now while the tested and the calculated results are reasonably near each other, when compared on this basis, they become remarkably so when calculated on a more rational basis. In the lap-joint tests it was found that the strength of the metal in the net section increased over that shown by the preliminary tests where steel plate was used, and likewise decreased where iron plate was used; now substituting these values as found for the tensile strength of the metal in the net section and recalculating the efficiencies of the joints, the efficiencies are as shown in column No. 9. The values in this column are seen to vary from those in column No. 10 by a maximum of 3.1, or a percentage variation of 3.6 per cent.

These facts can better be grasped in the form of a diagram, as shown in Fig. 2, tests Nos. 298 and 299 being omitted for reasons explained later. The full line of this diagram shows the tested efficiencies, calculated from the breaking load shown by the tests and assuming the strength of the solid plate to be identical with that shown by the preliminary tests of the sheets. The dotted line shows the efficiencies that would have been expected if the tensile strength of the metal in the net section had been of the average strength shown by the preliminary tests. The dashed line shows the efficiencies that would have been expected if the strength of the metal in the net section had increased for the steel plate and decreased for the iron plate in the same proportion as indicated by the tests of the lap joints. The writer believes this last method of calculating the efficiency to be the most logical, as it very materially reduces the differences between the actual results of the test and those which might have been predicted before the tests were made.

Flexibility of Strap has Influence on Method of Joint Failure

Tests Nos. 298 and 299 were omitted from this comparison, for notwithstanding the close agreement between the tested and calculated results, there are decided evidences that the flexibility introduced by the bend in the strap had considerable influence on the method of joint failure. In these two tests, considering that the shearing strength of the rivets had been up to the average, the efficiency of the joints should have been about 96 per cent. to have failed as they did. It is very unlikely that there could have been a falling off of 40 per cent. from the average shearing strength of rivets, as would be indicated by these two tests, and the most plausible explanation is that the flexibility of the strap permitted the inner rivets to shear before those in the outer row had been strained to their full shearing value, dividing the failure into two parts instead of the simultaneous shearing of the rivets in both rows. It is interesting to note that if the rivets of the inner row in test No. 299 sheared at exactly the average for iron rivets, the net section of the plate between the rivet holes on this row sustained a load of 8.8 per cent. in excess of the average for the net section of steel plate, or in other words if the relative strengths of plate and rivets had been the same as shown by the averages of the other tests, the net section of plate between the rivet holes of the inner row should have broken instead of the rivets shearing on this row; the difference in strength is, however, only the same as that between the average and maximum shearing values found for iron rivets.

It should be noted, notwithstanding the evident influence introduced by the flexibility of the strap on the shearing strength of the rivets in tests Nos. 298 and 299, that the strain required to produce distortion, added to the actual strength of the joint, was so great that the breaking load as shown by the test was actually in excess of the calculated strength of the joint.

Strap must Add Some Strength to Joint

While eight tests of any form of joint are far too few to determine conclusively its value, still owing to the care exercised in obtaining materials of uniform quality for these tests, and the numerous tests of lap joints made of the same material which are available for comparison, together with the marked uniformity shown between the tested and calculated strengths, the following conclusions seem justified.

When any lap seam, in which the diameter and pitch of rivets is in reasonable proportion to the thickness of the shell, is reinforced by a strap of the same thickness, the strength of the reinforced joint may be safely assumed to be equal to the calculated strength. If the thickness of the strap is much less than the thickness of the shell, the flexibility of the strap will likely influence the apparent ability of the rivets to resist shear, but it must add some strength to the joint, and the strap would have to be extremely thin, as compared with the shell plates, before it would cease to be of practical value.

Underground Insulation of Steam and Hot Water Pipes*

Underground insulation of such pipes is difficult for two reasons: First, on account of dampness getting into the covering and being with difficulty driven off, the pipes being confined by the earth; and, secondly, because the coverings themselves are liable to be attacked by destroying influences found in the earth. These, combined with the heat of the pipe inside and dampness on the outside of the covering, mean certain death sooner or later to anything of an organic nature. Consequently, the future insulation of these pipes must of necessity be confined to either the tunnel or some form of conduit composed entirely of inorganic substances.

No one will dispute the statement that a tunnel is a pretty expensive proposition, but in a good many ways it has advantages which are worth consideration. The pipes are always accessible and if a leak occurs there is not much trouble in locating it so that repairs can be made without much difficulty. New pipes can be added from time to time as occasion requires, the tunnel being erected in a permanent manner and of size sufficient to accommodate additions. On the other hand, the first cost is very high, the excavation being relatively much larger than would ordinarily be required for the number of pipes contained. The pipes must be separately insulated and as it is never thought necessary to cover the flanges under such conditions, the loss of heat from the pipes is sufficient at all times comfortably to heat a space, as a rule, approximating the same number of cubic feet as are contained in one-quarter of the buildings which are to be heated. The argument is sometimes advanced that once this space is heated the loss is very slight, and to some extent this is true, but not by any means entirely so.

The other system is that using vitrified sectional conduit. All the materials are absolutely inorganic, the shell being composed of a carefully selected and thor-

*Abstract of paper presented by Harry Gillet at the Toledo meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers.

oughly ground and mixed combination of stoneware clay. After the material passes from the molds it is properly treated before being placed in the kiln to avoid warping of the sections, this being extremely important. The conduit is scored in process of manufacture so that it can be readily split, which is done before shipping, each half being so marked that it can be identified on arrival in order that the original tops and bottoms may come together. Before splitting, each conduit length must sustain a transverse test between hardwood supports which cover one-third of the entire circumference of the conduit.

The filling or insulating material is composed of asbestos fiber and sponge, which is so intermixed that a maximum number of confined air cells are obtained.

The pipes are carried on roll frames imbedded in concrete, special tees being provided for this purpose, and whenever it is found necessary to anchor or turn a corner, brick pits are built. Almost any number of pipes may be placed in a single conduit and it is purposed that no pipe shall have less than 3 inches of the insulating material around it. The pipes are perfectly insulated and the entire conduit, with its contents, is self-contained. The loss in pressure is practically only that caused by the friction between the steam or hot water and the interior surface of the pipes.

This conduit can be laid within 6 inches of the top of the ground, snow not melting directly over it, as long as the atmosphere is below freezing point, according to actual observation.

The question of installation is a vital one with this, as with all other mechanical devices, especially so as it is of the greatest importance that no leakage of water shall occur. The lower half sections and the roll frames must be in perfect alinement, and it is absolutely necessary that the pipes shall be tested with a cold-water test of at least 50 per cent. in excess of the steam pressure to be carried before the top half-sections are placed or any insulating material put on; neither should calking nor rusting of joints be allowed. The job of steam fitting must be perfect and experience teaches that by following this course it will remain perfect.

Observation tees are provided in case it is necessary at any time to look for a leak, but after a long term of years, during which time many thousands of feet of the conduit have been placed underground throughout the eastern States, it was proved that no observation is necessary and the reason is simple. In the first place the necessity for careful and proper installation has been duly recognized and taken care of; there is no chance of anything attacking the pipe from the outside, and with this danger eliminated the chances for necessity of renewal are very slight. In case, however, it does become necessary, after a long term of years, the defective pipe is easily located and the trouble and expense of renewal quite small.

Wooden covering cracks and allows the surface water to enter the crevices, so that the heat losses are sometimes equal to 30 to 40 per cent. of those of bare pipes. A new and good job would show an average loss of 20 per cent. of the loss of an uncovered pipe. Various substances have been tried out, but most of them deteriorate easily, so that financially nothing was found to equal, as an efficient insulating material, water and heat-proof substances which could be molded into convenient shapes, and be made to entrap a lot of air; for, still and stagnant air is the very best kind of an insulator.

After many laboratory tests have been made on a large variety of substances, asbestos was found to fill the requirement best. It can be worked up easily into any shape, dense or loose in construction, and is not easily damaged by vibration of pipes, etc.

Some Friendly Suggestions to Gas Producer Builders

By F. C. Tryon

Some people who have installed gas-producer plants have made a great hue and cry because these producer plants require close and careful attention, forgetting that it is but a small proportion of what would have been necessary with a steam plant. They seem to have had the idea that it is only necessary to feed a certain amount of coal to a producer in the morning and remove a few ashes at night, and the plant would run itself in the meantime. This erroneous impression was first created and spread broadcast by the descriptive literature issued by some manufacturers of gas-producer plants.

Contracts of sale have usually contained vague wordings as to the guarantees made, wherein the conditions named are almost impossible to secure, and if not attained, leave the guarantees of no effect, and what is worse, the real influence that has finally brought the purchaser to the point of signing the contract has been specifically eliminated from the contract itself by the following sentence very often found in such contracts: "No promises or conditions written or verbal made previous to the signing of this contract shall be considered a part of it unless written herein."

The actual results obtained and regularly obtainable with a gas-producer plant are sufficient in themselves to bring this class of power apparatus into general use, without any recourse to subterfuge, deceit or anything other than straightforward, sound, honest business methods. It is not necessary to talk one pound of coal per horsepower-hour when you know it will probably require one and one-quarter pounds. If the plant makes a horsepower on one pound of coal per hour the customer will be that much better pleased with his plant, and if it burns one and one-quarter pounds no one will be discredited or disappointed. It is worse than foolish to try to make a customer think a producer-gas plant will run itself or only requires occasional attention, when you know that the more careful and intelligent the operator the more satisfactory the results. Gas-producer manufacturers should adopt generous dimensions of all the different parts of the apparatus they supply, give guarantees that can be fulfilled in everyday intelligent operation, get such a price for the equipment that they can at all times afford to stand behind their guarantees and make good any deficiency in materials or design, and last but not least, retain interest in a plant, even after it has been paid for, following up its performance and rendering whatever assistance may be feasible to improve that performance. Moreover, if improvements in design or operation shall be developed, it is always a good policy to give the old customer the opportunity of having the benefits of these improvements if he desires them. Builders should also be careful to send into the field as salesmen only conscientious men who thoroughly know the apparatus they are talking about, send as erecting superintendents men who not only know how to put up and operate the plant, but who know how to superintend and direct other men, and also how to instruct the engineer in charge of the plant to handle it properly after he leaves it, especially what to do in case of extraordinary conditions, how to overcome troubles, how to watch for them, what their indications are before they arrive, and what moves to make to prevent them.

Each manufacturer should have a school or test plant where the erecting engineer should be thoroughly instructed before he is sent into the field as superintendent of erection. At this school one of the first subjects for instruction should be the systematic manner of handling a producer; if every movement and action is directed by a well-thought-out and intelligent conception of results to be attained, there will be no lost motions or lost time. If every erecting engineer had received such instructions and carried them with him to to the plant he has put into operation, there would have been many thousand dollars saved to those who have passed through the educational period of getting gas-producer equipment into successful operation.

The Plunger Hydraulic Elevator

Operation of the Pilot and Main Valves in the "Standard" Plunger Elevator Clearly Explained; How the Adjustments Are Made

BY WILLIAM BAXTER, JR.

In order to explain the operation of the pilot valve shown in Figs. 282 and 283, larger drawings, Figs. 284, 285 and 286, are shown, the first being a vertical longitudinal section, the same as that shown in Figs. 282 and 283, but on a larger scale, the second a cross section through the center of the pilot valve, and as seen looking at Fig. 284 from the right side, and Fig. 286 is a top view showing a section through the upper end of the pilot valve on lines *X X* in Figs. 284 and 285. To the operating lever *C* is attached a connecting rod *K*. This rod guides a nut *L* that runs on a screw *L'* cut on the upper end of a shaft *L"*. (See Fig. 285, also.) This shaft also carries a pinion *P'* that meshes in a rack *V* mounted upon the end of the main valve stem. Below this pinion are two spiral cams *a* and *a'*, also mounted on the shaft *L"*. Between these cams there are two similar cams *b* and *b'* fastened to the plate *b"*. The shaft *L"* is connected with the lower end of the pilot valve by an arm *D*; hence, if the lever *C* is raised the pilot valve is raised, and if the lever is depressed, the valve is likewise depressed. When the lever *C* is raised, the cup packing *O* at the upper end of the pilot valve will be raised, and as can be seen in Fig. 285, water from the supply pipe will pass through the opening made by lifting the cup *O* and pass to the central pipe that connects with the back end of the main valve cylinder; that is, to the pipe *P* of Figs. 282 and 283. This water will move the main valve to the right, as already explained in connection with Fig. 282, and the rack *V* will rotate the pinion *P'* so as to cause the screw *L'* to run down in nut *L*, carrying the pilot valve downward and returning the cup packing *O* to the position in which it is shown in Fig. 285. This will stop the flow of water into the main valve cylinder and thereby stop the movement of the valve to the right.

The movement of the rack *V* must be sufficient to return the packing *O* to its seat, so that if the lever *C* is raised a short distance the movement of the rack *V* to the right will be small, and if the lever is raised as high as it can be moved, the rack will travel to the right its maximum distance. In other words, the amount of opening of the main valve must be directly proportional to the distance through which the lever *C* is moved. Movement of the lever *C* downward will have the same effect, but in the reverse direction, for then the pilot valve will be depressed and the lower cup packing *B* will be drawn down so that the water in the back end of the main valve cylinder, returning through pipe *P*, will be able to flow into the pilot valve through the cen-

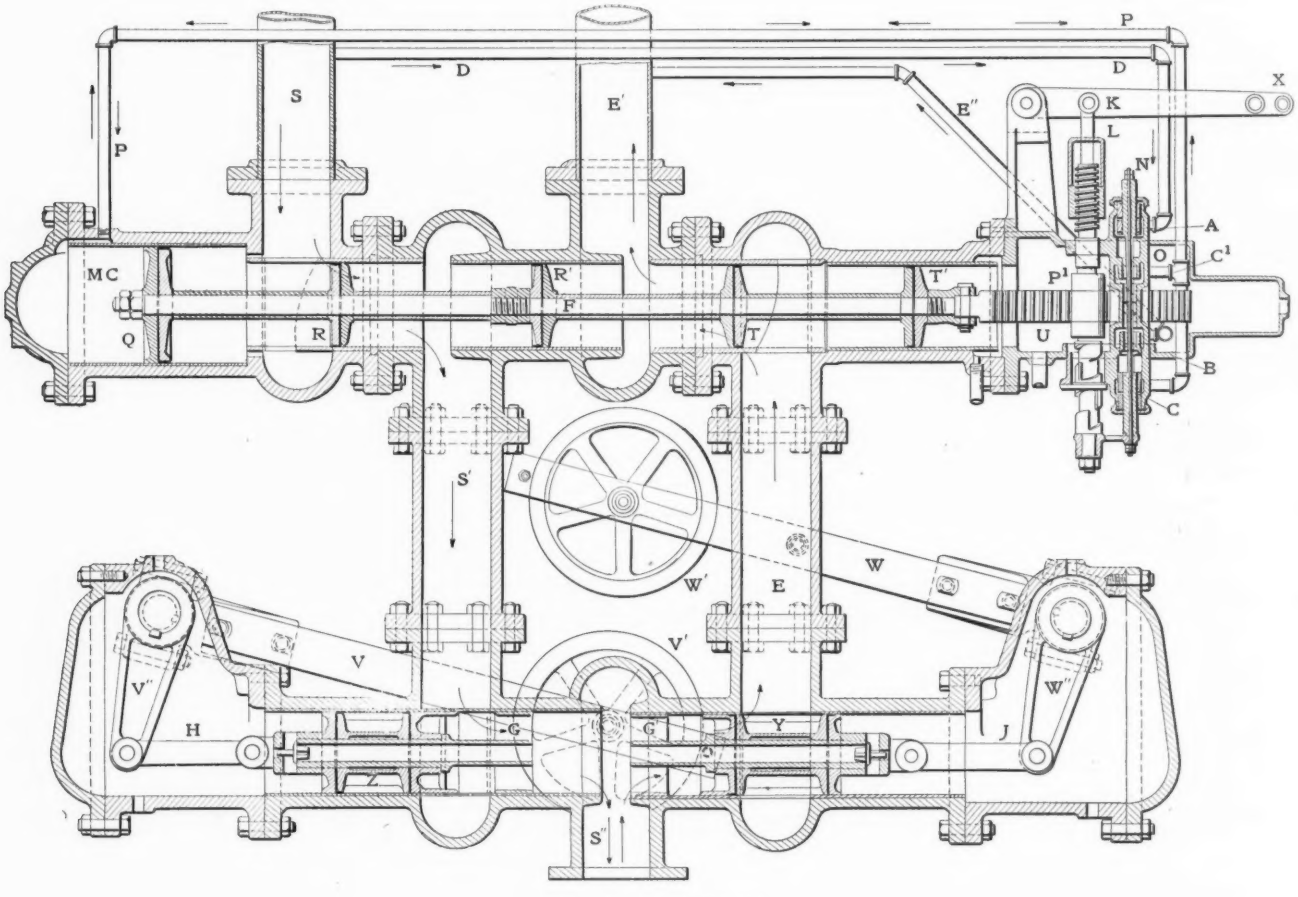


FIG. 282 (REPRODUCED)

tral inlet and passing down to the lower end will enter the valve cylinder and run up past cup *B* and out into the discharge pipe, which in Figs. 282 and 283 is marked *E*. As soon as water begins to flow out of the back end of the main valve cylinder, the main valve will move to the left, and the rack *V* will rotate the pinion *P'* in the direction to work the screw *L'* upward in the nut *L*, thereby lifting the pilot valve and returning the cup packing *B* to its seat to close the outlet and prevent further movement of the main valve.

The stationary cams *b* and *b'*, in conjunction with the cams *a* and *a'* on the shaft *L"*, are provided to prevent sudden reversals of the elevator. If these were not used, the operator could swing the car lever over from the full-speed position upward to the downward full-speed position almost instantly, and as the car motion could not be reversed in so short an interval of time, the plunger would be drawn away from the water, with the effects already explained. With the cams arranged as shown, the operator can only move the car lever back to the stop position; it will not move farther until the pilot and the main valves have been brought back to the stop position; that is, to the position in which they are shown in Fig. 284. The cams *a*, *a'* and *b*, *b'* are made of the same pitch as the screw *L'* and the distance between *a* and *b* or *a'* and *b'*, when in the stop position, measured parallel with the axis of the shaft *L"* is equal to the full stroke of the pilot valve. Therefore, if the lever *C* is moved its full swing in either direction, the corresponding cam on the shaft will bring up against the stationary cam opposite it, and the other cam on the shaft will be drawn to double the initial distance from the other stationary cam. As soon as the main valve begins to move it will rotate the last-named shaft cam around over the high point of the stationary cam, and as the thread of the screw *L'* and the cam pitch are the same, the distance separating the cams will be just equal to the distance through which the shaft *L"* has been raised; hence, if the operator moves the car lever in the reverse direc-

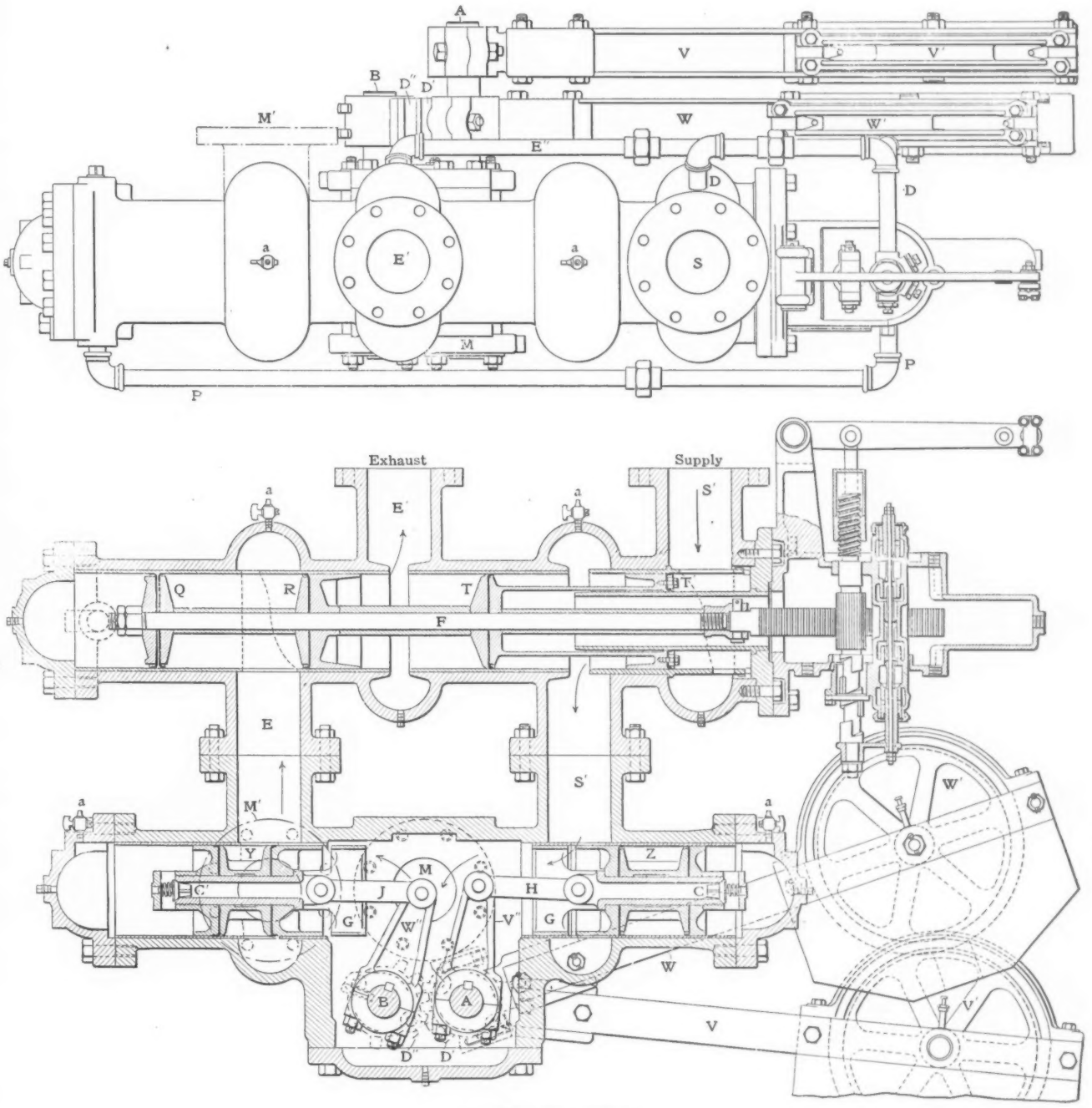


FIG. 283 (REPRODUCED)

tion, he can only move it as far as he did when starting, that is, back to the stop position, but no farther. If, after the operator has moved the car lever to the central position and finds that it will go no farther, he persists in keeping up the pressure on it, when the shaft cam passes beyond the high point *c* or *c'* of the stationary cam, the lever will be freed and the operator will be able to move it until the shaft cam strikes the stationary cam, but this will be after the pilot and main valve have been brought to the stop position, and the elevator has likewise stopped.

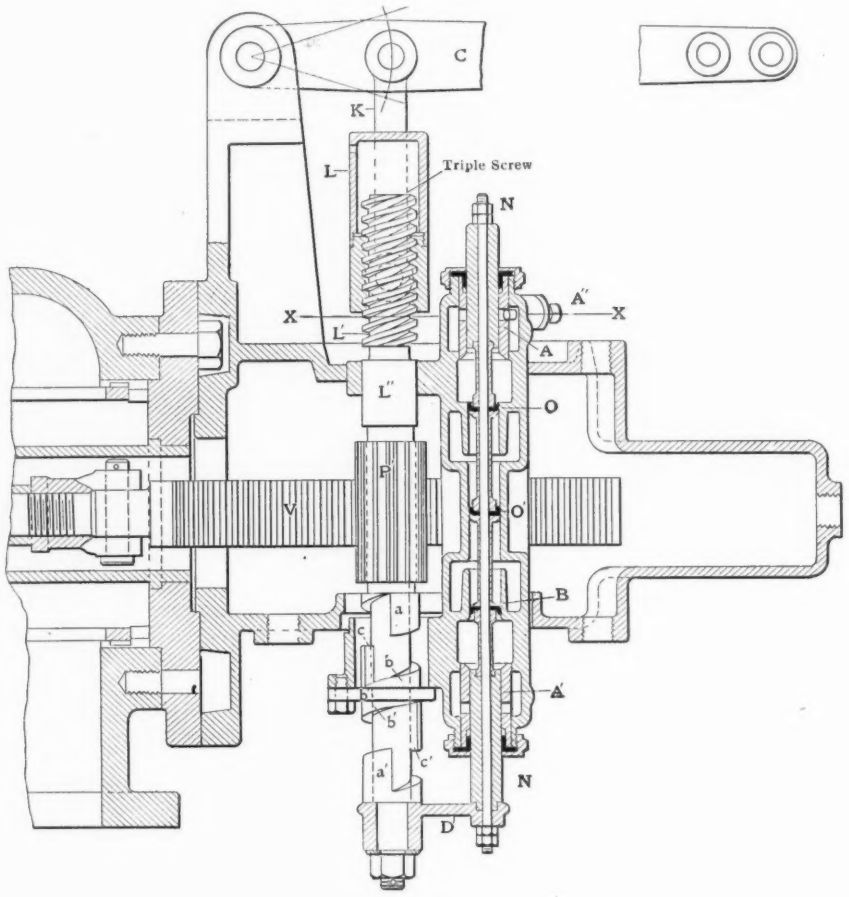


FIG. 284

In addition to the cams *a*, *a'* and *b*, *b'*, several adjusting plugs are provided to regulate the flow of water through the pilot valve. Looking at Figs. 284 and 285, it will be seen that at the upper end of the pilot valve there is a plunger *N* that slides through a sleeve *A*, and at the lower end there is another plunger *N'* that slides through a sleeve *A'*. These sleeves have three port holes set on a diagonal line and opposite each port there is an adjusting plug *A''*; the positions of these are shown in Fig. 286. By means of these screws the opening through the port holes can be varied to any extent that may be desired. In addition to these adjusting plugs there are two others that screw into the holes *F'*, shown in Fig. 285. The upper plug *F'* controls the flow of pressure water into the space at the back end of the main valve cylinder, and the lower plug controls the flow of the discharged water. From Fig. 283 it can be seen that in order to start the elevator on the up trip with this type of valve it is necessary to move the main valves to the right, as the drawings are presented, to allow water from the supply pipe to pass into the cylinder. To move the main valve to the right, pressure water has to be admitted to the space back of the piston *Q*. To start the car on the down trip the main valves have to be moved to the left, in order that the piston *R* may uncover the ports opposite the pipe *E* and permit water to escape from the cylinder. To move the main valves to the left, water must escape from the space back of the piston *Q*. To stop the car on the up trip the main valve must move to the left, hence water must be drawn from the space back of the piston *Q*, and to stop on the down trip the main valve must be moved to the right; hence water must be admitted to the space back of the piston. The rate of flow through the pilot valve from the supply pipe to the central outlet that connects with the pipe leading to the space back of the piston *Q* is controlled by the adjusting plugs *A''* opposite the port holes in the upper sleeve *A*, Fig. 285, and also by the plug in the hole *F'*. In starting the car on the upward trip it is necessary to

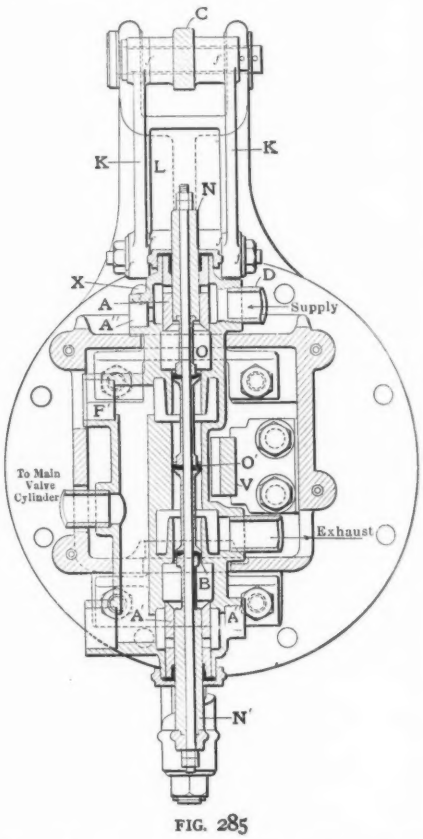


FIG. 285

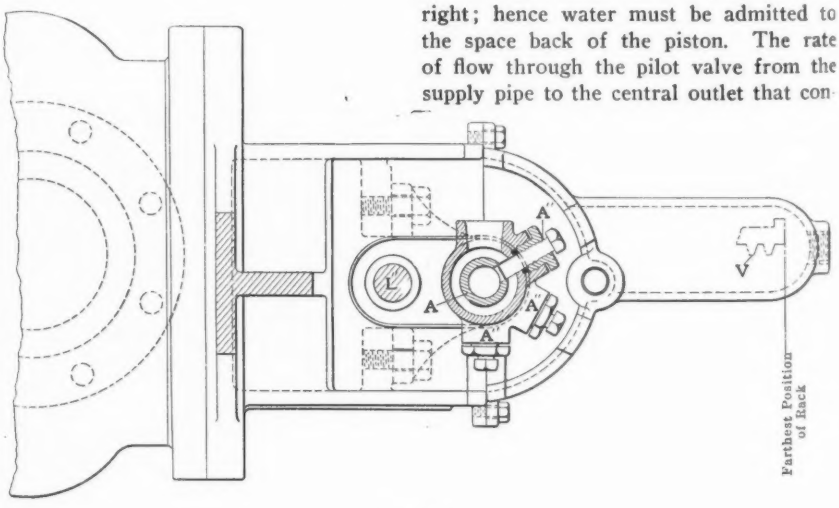


FIG. 286

open the main valve quickly, to get the full pressure in the lifting cylinder, because the lead has to be started from rest. In stopping on the down trip it is necessary to shut off the flow quickly because the momentum of the downward moving car and plunger will force a large quantity of water through a small opening; therefore, the adjustment that is proper for giving the car rapid acceleration in starting on the up trip is also proper to give rapid retardation in stopping on the down trip, and this adjustment is made by the same set of adjusting plugs, namely, those at the top of the pilot valve.

In starting on the down trip it is necessary to open the valve slowly, so that the weight of the car and plunger may not force the water out of the cylinder so fast as to cause the car to run down too rapidly; in stopping on the up trip, also, it is necessary to close the main valve slowly, in order not to stop the flow of water into the cylinder faster than the momentum of the counterbalance will permit the car to stop, otherwise the plunger will be lifted from the water. As already explained, the car is started on the down trip and stopped on the up trip by letting out the water in the space back of the piston Q, and in escaping it passes by the adjusting plugs F and A'' at the lower end of the pilot valve; hence, the adjustment of these that is proper for making stops on up trips is also proper for starting on down trips. When the lever C is moved the full distance the pilot valve is given its full stroke, and the three port holes in the sleeve A opposite the plugs A'' are uncovered by the plunger N so that the maximum quantity of water flows through the pilot valve. When the lever is moved less than the full distance, the pilot valve is given less than the full stroke, and all the port holes in A are not uncovered by the plunger N. Therefore, if the operator desires to get under full headway in the shortest time possible all he has to do is to swing the operating lever all the way over, and the speed of the car will be accelerated at the highest rate for which the pilot valve is adjusted. If the operator does not desire to run at full speed he moves the car lever part of the distance and the plunger N is not raised high enough to uncover all the port holes in the sleeve A, so that the car will not only run at a reduced speed, but will also get under way more slowly.

Of the total estimated power at present produced by prime movers in the United States about 26,000,000 horsepower is produced by steam engines, 3,000,000 horsepower by water motors, and 800,000 horsepower by gas and oil engines. These figures emphasize the present position of the steam engine in our industrial development and the relatively much less important place now occupied by water power.—H. St. Clair Putnam at the Conference on Natural Resources.

Running a Parsons Turbine

By H. M. MacSweeney

In the operation of the turbine there seems to be a lack of confidence on the part of many engineers, and more especially among the older men in the business. Many times we find that for want of knowing where many of the little troubles lie, a piece of machinery is criticized. It no doubt goes "against the grain" with some men to be told where and how to locate trouble, and many men will sacrifice "knowing" for their own pride, and more especially if such information comes from a younger man. The following is written and based on observations made on a 500-kilowatt Westinghouse-Parsons turbine which has now been running three years. During that time the machine has given excellent service. To operate the

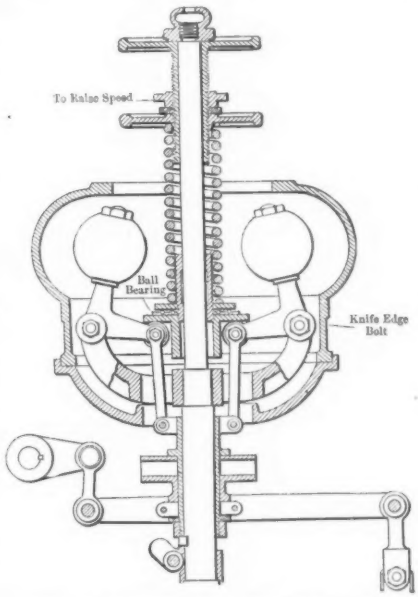


FIG. 1. GOVERNOR OF PARSONS TURBINE

turbine successfully requires an engineer familiar with its working, and who will know by the sound and vibrations made just what its ailments are. One point to be remembered by engineers who are about to take charge of such a turbine is not to wait for the erecting engineer to post them on conditions of turbine running, etc., for if they do, they will wait too long. Out of twenty erecting engineers on turbine work the writer has found only one man who felt like opening his mouth and giving a hint as to what to expect.

Dropping Out of Blades

One morning, just after starting up, when the speed was no higher than 100 revolutions per minute, a tinkling noise, just as if someone had shaken a bag of nails, was heard. After a little while the noise stopped, and no more was heard for that day. Next morning the same noise was heard for about the same period, so it was decided to investigate the trouble next day. This was done, and one-half a row of blades was found out. Luckily it was the end row on the low-pressure end, and they could do no more harm than drop into the exhaust. At the time of the noise one man said it was the water coursing through while the turbine was running slowly, but this was not the case. Water will make no metallic sound against the blades, only a dull "chunky" noise, and the turbine will vibrate heavily for a time until the water is forced through and the turbine settles down to speed up. It is my advice, if any such metallic sound is heard and the turbine runs O. K. otherwise, to investigate. It will save blades, time and labor, and if only one row has fallen out, remove the loose blades and thoroughly look over all other blades, both rotary and stationary. When this is done, put on the cover and start the turbine. It will run, minus one row of blades, until there is more time to put new ones in place. When the cover is removed, it would be a good plan to straighten all bent blades.

Feel the Bearings

A bearing is essentially the most important part of a turbine. No chances can be taken with a hot bearing on a high-speed turbine. All other parts can be put out of danger in most cases by shutting down, but on a bearing it is different on account of the high speed and considering how long it takes a high-speed turbine to stop completely. Get into the habit of feeling the bearing, both for heat and vibration, and a hurry call to the throttle will often be avoided. Also be careful with the oil and see that the pump is working properly. In doing these things regularly the hand will soon become trained in detecting any unnecessary warmth, noise or vibration.

In the Parsons turbine the bearing consists of a brass tube. It has a dowel arm which fits into a slot in the bearing cover, and around this tube there are three other tubes held in place by a nut and set screw. It is a good thing to watch this nut and set screw. Vibration, no matter how slight, is very apt to work them loose. Taking the bearing covers off too often is apt to make them leak oil, and, if such is the case, it will be found that two strips of fuse or lead wire (6-ampere) laid lengthwise on each side of the oil groove on the face of the bearing pedestal, with the cover put on carefully, will make a tight joint. When tightened gradually, the lead wire will squeeze down almost as thin as paper and stop the leak.

The Governors Require Watching

One day the governor was working peculiarly. Its operation was irregular, and this had such an uneven effect on the pilot cutoff valves that the working of the primary and also secondary valves was affected, causing the turbine to speed

up and slow down alternately. Upon investigation it was found that one of the knife-edge bolts on which the governor balls rest was broken in two. This meant a new bolt, of course, and as the new one was not at hand, no time was lost in having one made. Such parts should be kept in stock, for if they do not break the knife edge will wear off, and when this edge becomes too badly worn, the governor will not act properly, or as sensitively as it should. The connection between the governor and valves will bear watching for lost motion. Sometimes it is necessary to put in new bushings, which can be cut from the right size of brass tubing and the oil holes bored when the bushing is in place. It is advisable to keep the governor clean. To do this, remove the cover and use a cloth, not waste, saturated with a little kerosene oil.

The overspeed governor should be tested once a week or oftener. To do this, push upward on the connecting rod between the pilot valve and governor rod with sufficient force to make the primary valve raise and stay up. Do this not longer than 10 seconds, for if the "overspeed" does not act in this time, there is something wrong. Look for trouble by removing the entire cover. The clutch nut may be turning around on its thread, or the dowel arm may be broken off. If not, the "overspeed" is set too high and should be cut down. This, of course, applies to a turbine that is running at the right speed. If the working speed is 3600 revolutions per minute, the "overspeed" should not be higher than to pop off at or about 4000 revolutions per minute (93 revolutions of pump). A position any higher is not safe. If the safety valve on the main steam line does not open up after the blowout to the overspeed trip valve has been shut off, tap lightly with a mallet around the bonnet to work the valve loose.

Care of the Primary and Secondary Valves

The main or primary valve and also the secondary or overload valve require cleaning from time to time, especially around the piston and piston rings. It is advisable to use a light lubricating oil for these valves and not too much of any. A heavy oil will be found to be too gummy and sticky, and will deposit a soot around the piston, which makes the valves work stiffly when starting up, and even when heated through has a bad effect on the good working of the valves. The pilot valves can easily be cleaned once a week by taking them out and removing any oil blackness. A little kerosene oil is admissible for this, and on no account use sandpaper or emory cloth, no matter how fine, for leaky valves will be sure to result. Clean the grooves around the stem and look at the ends of the stem and remove any dirt or soot. Do not use oil on these valve rods; they usually get enough lubrication otherwise.

If the primary valve does not seat properly and does not shut off the steam when seated, take the valve out and examine the seats. If the seats are rough they can be ground in, and if a heavy grinding is required, use ground glass and emory and finish with fine emory. Be careful to wipe the seats and disks well after grinding. If the valve does not seat well after it has been put in place again, remove the top cover and hand lever and put in, if required, a thin washer, or size to suit, on top of the spring. If it is not known what size of washer to use, unscrew the cover, and if it does not raise ⅜ inch, by spring compression, from the bottom flange joint, make up the difference in a washer. It will be found by doing this that the spring will have more

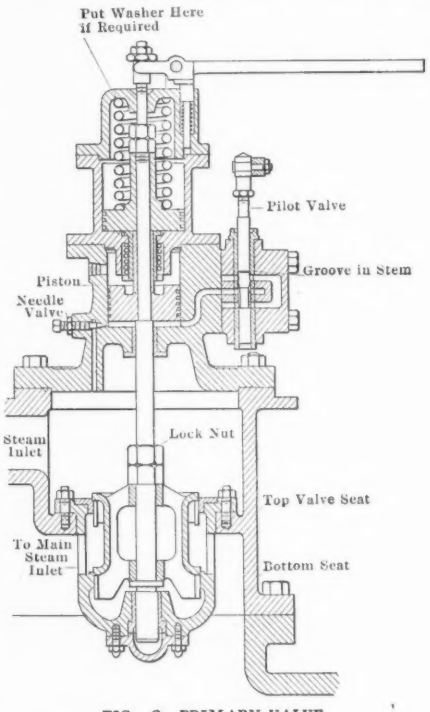


FIG. 2. PRIMARY VALVE

compression to seat the valve. When the valve is out, see that the lock nut and nut on the rod to the valve disk are secure, for if these are loose the valve will turn around and work with lost motion.

When shut down it is a good thing to raise the valve with the hand lever and put a block under the top nut and lock nut to keep it open. This will allow the water to pass through from the top of the valve disk and seat. If it is found that the primary valve does not take care of the load properly, unscrew the bottom needle valve a little to admit more steam to raise the valve. The top needle valve takes care only of the dashpot for an easy downward drop of the primary valve. The needle valves on the secondary valve work differently and rarely give trouble; the lower one admits steam which is cut off during exhaust by the pilot valve, and the upper one should be open enough to keep the valve from bobbing due to puffs of steam within the turbine.

A Few Leaks

Many times an oil pump gives trouble from want of new packing and packing of right size, a packing that ought to go in square without pounding. It is a good thing to soak the packing in oil before putting it in, as it helps to lubricate while the pump is getting oil up. The oil will soak through, of course, but takes some time to do this. If the oil turns a whitish yellow and does not seem to be well mixed, water leaks in the cooler may be looked for, or, when shut down, water leaks from condensation through the water packing glands to the bearing. Do not turn on over five pounds of water on the glands, as much more than this amount will cause the water to squirt out of the glands and travel along to the bearing. If when starting up there is trouble with steam leaking through the glands, turn on water for a second or two and shut it off again. This much will keep steam from leaking through until the turbine is up to speed. If the oil-cooling system is independent of the water glands, it is a good plan to leave a little water turned on at all times. Water in circulation is much better than stagnant water in the coils. If the throttle valve or bypass leaks, see to it. If there is a large exhaust from other engines with back pressure, shut off the exhaust from the turbine, as steam should not be allowed to leak through the glands at any time. If the oil bubbles or gives out blue air, add more oil to the oil cooler. In shutting down with the condenser on, that is, if it is intended to shut down the condenser anyway, it is a good thing to close the throttle, turn off the gland water and allow the turbine and condenser vacuum to die down together. This draws any water from the glands which may be there.

Generator Observances

A few everyday operating observances may be given for the generator. There may often appear a false ground on the collector rings. This may be due to dampness or deposited dust, which may bridge across from the inside rings to the field rotor, and from the outside ring to the oil-guard ring and to the shaft. This may be taken off easily by holding a brush for the purpose, or piece of cloth, between those places, knocking this dust off as the machine revolves, or it can be blown off with compressed air. It is a good thing to test for a ground after shutting down, for then the operator will be able to tell best where it lies—in the field, collector rings, or as stated above. A few weeks ago one of the oil-guard rings came off while the turbine was running. It was put on again by holding it steady and lightly pressing a piece of wood against it. There is no danger in this, only be careful and take it easy.

Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

Horsepower of Compound Engines

Replying to the letter of F. H. Ball, on page 534 of the September 29 number, I would say that there is nothing in my article on "Failure of a Cross Compound Engine" to cause anybody to conclude I believe that all compound engines are failures. I described an actual case where one did fail and gave reasons for it. The high-pressure cylinder alone carried the full load for several days. In fact, it carried more than the average load on account of a snowstorm, which, of course, made it take more power to run the cars. I gave facts and figures to show how and why this was possible. Viewing the matter in this light, there seems to be no chance for Mr. Ball or anybody else to argue the case, as facts are stubborn things to deal with.

It is quite possible that some steam users believe that a cross-compound engine develops twice as much power as could be secured from the high-pressure cylinder alone, but somebody ought to show them their mistake without delay. I challenge Mr. Ball to show how it can be done, or to produce indicator diagrams from an engine in which it is accomplished.

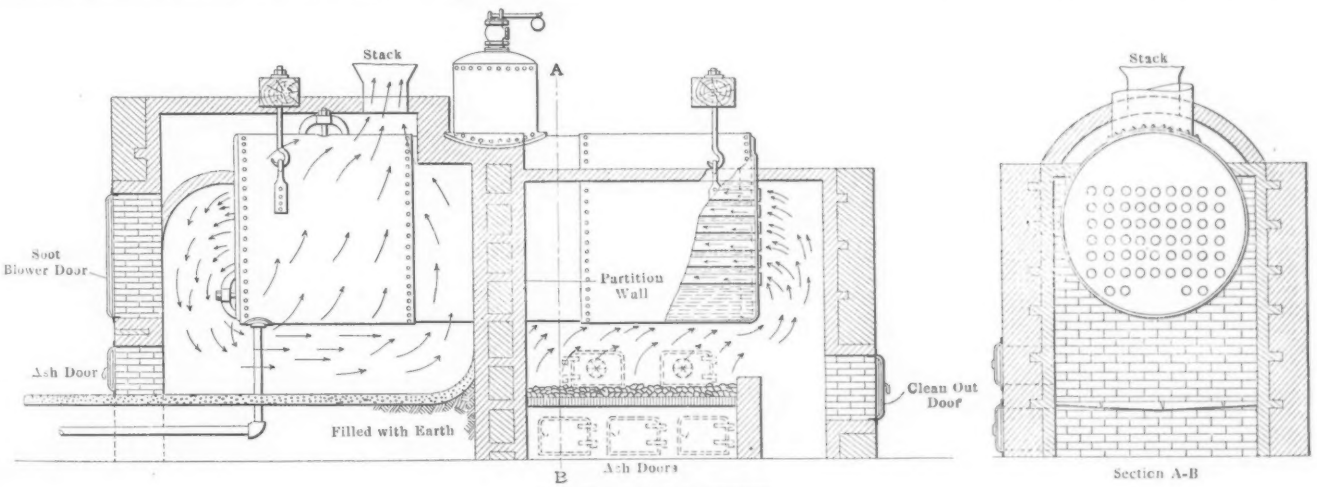
The primary object in using a compound engine is to save steam and not to develop more power. If more power is wanted without regard to consumption of steam, it is proper to put a larger cylinder on the old frame, which is often done in practice.

W. H. WAKEMAN.

New Haven, Conn.

Boiler Settings

I herewith submit a sketch of what I think would be an improvement on Mr. Wheeler's idea of an improved boiler setting illustrated on page 487 of the September 22 number. Instead of having the side walls extend along the water line behind the partition, I would leave the entire rear half of the shell exposed to the gases after they pass through the tubes, as shown in the accompanying sketch, thereby causing the upper one-third of the shell at this end to act as a superheater. The space over the top should be such as to cause most of the gases to deflect down around the bottom of the shell at this end, and have the breeching connection on top as shown.



IMPROVED BOILER SETTING

The particular advantages of this form of setting would be in better circulation. The coolest part of the boiler would be the bottom of the shell at the rear end and mud and scale would settle there. I would also have one or two more blowoff connections along the bottom, just back of the partition, by which practically all sediment could be blown out. I believe all boilers should have two independent blowoff pipes, as one is liable to clog up at any time, unless frequently opened.

S. KIRLIN.

Little Rock, Ark.

Mr. Wheeler's layout of an improved boiler setting, at first glance, shows possibilities of improvement over the standard setting. However, the drawbacks caused by this arrangement, would, I believe, more than offset the apparent advantages. The increased draft necessary due to the large number of turns in the path of the gases, as well as the downward pull instead of a natural upward course, would make more air leakage through the setting possible and increase the cost of maintenance. Instead of being more smokeless, the short path of the gases before reaching the cold tubes would give less chance for mixing and consequently increase the smoke nuisance.

The difference in temperature of the gases coming in contact with opposite ends of the shell would tend to cause unequal expansion, and so shorten the life of the boiler. The advantage gained in space due to firing on the side, would hardly be appreciated, as the necessary room would still be required in front for the cleaning or removal of tubes. To my mind the same arrangement of grates and firing doors, with the gases passing under the shell in the regular manner, would possess all the advantages with none of its disadvantages.

G. R. HAIGH.

Detroit, Mich.

In the September 22 issue of POWER AND THE ENGINEER, Mr. Wheeler submits a scheme for a boiler setting which might be used in case it was impossible to have a firing room at the end of the boiler, but which violates all of the rules for obtaining good combustion.

In a properly built furnace the fresh coal is fed onto the front of the grate, so that the gases will pass back over the rear of the grate where the fire is hottest, and perchance becoming hot enough to ignite.

In case these gases do not become so heated, or should come in contact with the comparatively cold boiler before becoming ignited, they will not burn, and so do not do their part in making steam.

In Mr. Wheeler's design of a boiler setting the gases from the fresh coal on the front of the grate are not carried over the hottest part of the fire, but pass directly over the front part of the fire only, and up against the boiler, without a chance of attaining a hot enough temperature to cause them to burn. After these gases become cooled by contact with the boiler, they, of course, lose all value as a heating factor, and pass on up the stack as smoke.

F. L. BUSEY.

Urbana, Ill.

Condenser or Heater

J. L. Shrode's reply, on page 488 of the September 22 issue, to Markham & Co.'s question on putting a heater between the engine and condenser, contains the astounding information that he is able to heat feed water to 210 degrees with steam at about 24 inches of vacuum, or at a temperature of about 140 degrees. Just exactly how he accomplishes this reversal of all the known laws relating to the transmission of heat, or the conversion of energy, he does not make clear.

I would ask Mr. Shrode to go carefully over his power plant again with a reliable vacuum gage and trustworthy thermometer, and I believe he will find that the 24-inch vacuum is a delusion, or else that the heater is so clogged up that while the condenser shows a 24-inch vacuum, the back pressure on the engine is in reality about 15 pounds absolute, the difference being lost in the clogged heater. If he finds the heater clear then he surely will make the discovery that the feed water never gets to 210 degrees, by about 75 degrees, unless Kentucky water has a density and boiling point different from the common everyday sort.

My experience has been that 100 degrees was all that could be obtained when connected up in this way, but the saving justified the 50 or more degrees we got.

GEORGE P. PEARCE.

Exeter, N. H.

How Should Heaters be Connected Up?

Referring to the article on "How Should the Heaters be Connected Up?" appearing on page 365 of the September 1 number, the writer sees no reason why the steam leads to the cooking kettles or heaters should not be taken from a main steam header, as shown in the isometric diagram herewith.

The steam header is fed from each boiler, with a valve at the boiler and at the header. The valve next to the boiler should preferably be an automatic stop and check valve.

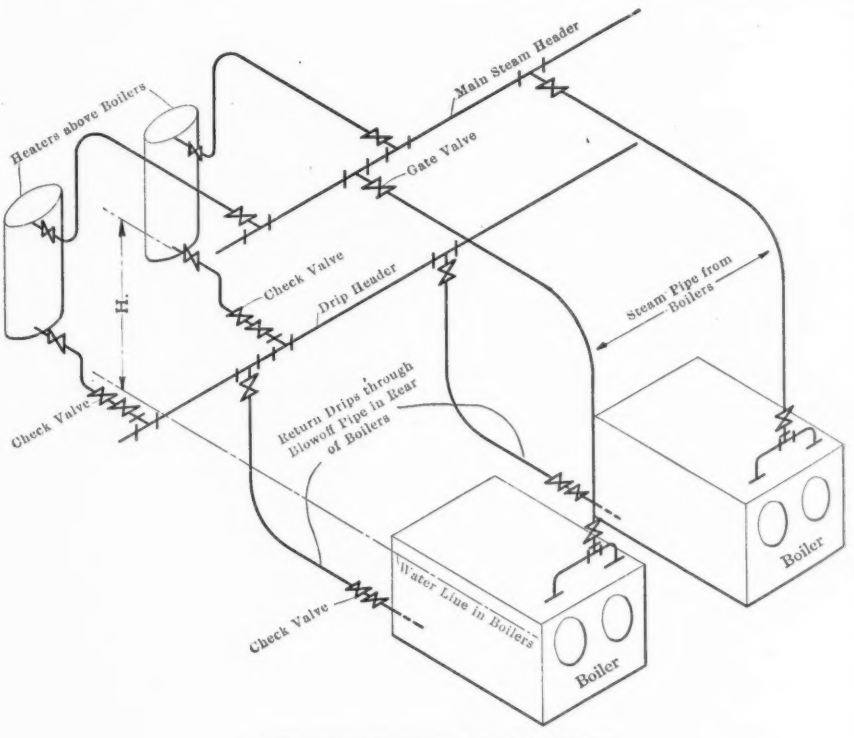
As the kettles are all situated above the boilers, the writer can see no reason why the drips should not be returned direct to the boiler. If the drip connection from the lowest heater is of sufficient hight above the water line in the boiler, the system should give satisfactory results.

In the sketch the drips at the bottom of the kettles are shown connected to a header through two gate valves and a check valve. The drip header, in turn, is connected in a similar manner below the water line of each boiler. The check valve in the connection between the kettles and the drip header is necessary to prevent the water in the header from backing up in any of the kettles, in case the pressure in the kettle falls below the pressure in the drip header. The check valve between the boiler and drip header in a similar manner prevents the boiler water from backing up. With this arrangement the drips can be returned from any kettle to any boiler as desired.

WILLIAM F. FISCHER.

New York City.

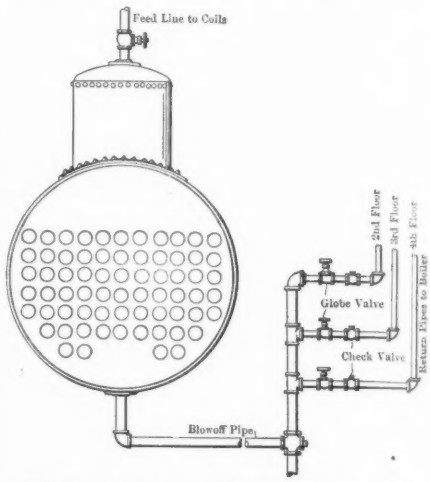
On page 365 of the September 1 issue, an inquirer asks for information regarding setting up a heater.



HOW HEATERS SHOULD BE CONNECTED

If I were doing the job I would run feed lines from the boilers to the heating kettles and coils, and run the returns direct to the boilers, thereby doing away with the pump and other apparatus which are needed where the returns from a heating system are returned to boiler by means of a pump.

I know that returning the condensation direct to the boiler can be done successfully, because I have had an arrangement of this kind under my charge, where the top floors of the building were heated with live steam and the water of condensation returned direct to the boilers. The



SHOWING PROPOSED HEATER CONNECTIONS

feed and return were arranged as shown in the illustration.

Kettles and coils were used for heating glue and the coils in these kettles were fed by the same feed line, as were the heating coils, and the water of condensation returned direct to the boilers.

Care must be given to the check valves in the return pipes to keep them tight, otherwise the system will not work properly.

H. JAHNKE.

Milwaukee, Wis.

A Compression Argument

The letter under the above title, by R. O. Richards, in the September 8 number, contains good, sound reasoning, and has given the writer courage to express his views in the matter, which, although somewhat radical, I will continue to believe correct until shown otherwise.

I believe in just enough compression to insure smooth running, without adjusting bearings too closely, to allow for expansion, should they heat for any reason. I believe this amount of compression to effect a slight economy of steam, instead of a waste, as many think.

I have two Corliss engines, both driving the main shaft by means of a friction clutch and rope drive. The smaller engine is held in reserve, to be used when the load is too great for the main engine.

When the friction clutch is out, these engines are under no load other than their own friction, still they cannot be started until the piston has reached a point 2¾ inches from the center on the head end and 3¼ inches from the center on the crank end, even with a boiler pressure of 150 pounds. I do not believe it possible to apply sufficient pressure on the pistons of these engines to move the flywheel with the pistons 10 per cent. closer to the center, as the effective length of the crank is small, and the friction on the bearings of the reciprocating parts and main bearing increases directly as the pressure is applied.

This shows very clearly that pressure on the piston within these points is of no service at the crank shaft. For this reason, I close the exhaust valves early enough to bring the compression up equal to the terminal pressure, by the time this point is reached, when carrying an average load. This adjustment leaves the pressure on the crank pin, due to the momentum of the reciprocating parts, to be absorbed by the higher point of compression, at a point where the pressure on the piston is of no service in rotating the crank shaft.

That there is a good mechanical reason for using compression, few practical engineers will doubt. I know, from experience, that bearings are cooler and wear less, and the engine operates more quietly with compression than without. I also believe that, although the noncompression diagram shows the greater mean effective pressure there is no gain in brake horsepower, as the increased friction due to this adjustment offsets it, whereas with compression this wasted energy is absorbed in the cylinder, effecting a slight economy and also keeping this unnecessary pressure off from the bearings.

Will some engineer pulling an electric load that is fairly steady, try both adjustments, and let us know the comparison between the indicated horsepower and the electrical horsepower in both cases?

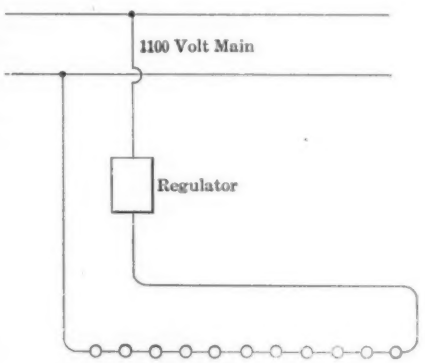
J. W. FOWLER.

Richard City, Tenn.

Mr. Grove's Series Lighting Circuit

Replying to the letter from D. M. Grove in the issue of November 17, I would say that reducing the wattage in the series circuit supplied by the secondary winding of his transformer will, of course, reduce the wattage in the primary circuit, but this will not necessarily reduce the current in ammeter No. 1. The inductive regulators will insert more inductance in the secondary circuit, and if they are sensitive enough to keep the secondary current constant, the primary current will remain practically constant, with a reduced power factor.

Take the case of a series circuit supplied directly from a constant-potential



MR. MALCOLM'S WIRING DIAGRAM

circuit, with an inductive regulator in series, as shown. Any decrease in load, either by using lamps of higher efficiency or by cutting out some lamps, will reduce the wattage but the current will remain practically unchanged; the power factor will be reduced proportionately with the load, by the extra inductance inserted by the regulator. For example, suppose the voltage of the main is 1100, that of the load 1000 and the current 6 amperes. The regulator will take up the difference of 100 effective volts, the wattage will be 6000 and the power factor will be $6000 \div 6600 = 0.90909$, or 90.91 per cent. Now if the lamps be reduced to 77 per cent. of their original number and the regulator keeps the current absolutely constant, the wattage in the circuit will be $770 \times 6 = 4640$ and the power factor $4640 \div 6600 = 0.7$, or 70 per cent. In practice the figures would be slightly different owing to the resistance of the regulator winding and the fact that the current cannot be kept precisely constant, but the discrepancy would be very small.

GEORGE W. MALCOLM.

Brooklyn, N. Y.

Boiler Room Practice

The question of the water line in return-tubular boilers is one of much importance, and one much neglected. In considering the water line in a 66-inch boiler, 2½ inches should be carried over the top row of flues. Too much water is bad, as it cuts down the steam room and causes the boiler to steam hard. In one plant the engineer was carrying water 10 inches above the top row of tubes and could not run his steam pump properly, as it carried so much water over to the cylinder.

A water column should be carefully placed, as it is a dangerous arrangement when not properly set. In blowing down a boiler it is well to open the spigot under the glass gage so as to make sure that there will be no false water level in the glass.

There seem to be various opinions in reference to the use of kerosene oil in the steam boiler. I cannot see any real gain in its use; it certainly will not remove scale, as it is thought to do by many who use it. It may prevent scale forming to a certain extent, as the oil will float on top of the water in the boiler and when the boiler is filled the oil will coat the plate and partly prevent the formation of the scale. As regards the oil penetrating between the plate and scale, causing the scale to shell off, I have but little faith in the idea. I have made careful tests on the use of oil in boilers and I see no benefit from its use. One thing is evident, however. Some boilers have been ruined by allowing oil to work with the boiler.

The gage should be blown out at least once a day and the small spigot connected to a pipe leading to the ashpit. Many of the automatic columns made today have a large globe valve at the bottom to blow off the column, but not one out of one hundred is piped to carry away the water. It is just as important to blow off the water column daily as it is to blow off the boiler. This will also tend to keep the column clean and free from scale. Should the top pipe become somewhat closed, the water line will show hight, and this is a most dangerous condition.

Recently I found a steam line that had been in service six months under a constant pressure of 140 pounds. The joints had been made with corrugated gasket, and strange to say all were leaking. A copper gasket will hold under a very high pressure if properly used. These gaskets when taken out were found to be filled with small punctures, where the steam and water had cut through. The joints were made up again by filling the recesses in the copper gasket with white and red lead. This made the joints absolutely tight. The lead forms a paste and, hardening, prevents the water from attacking the copper and cutting it out. I have made joints in this manner on a steam

line carrying 210 pounds pressure, and there was not a sign of a leak after years of use.

C. R. McGAHEY.

Lynchburg, Va.

Belt versus Direct Drive

The great advantage of direct or gear driving, as far as I have learned, is that you cannot use the automatic stop. I have heard of very serious accidents being caused by this apparatus not only failing to act, but preventing the engineer from getting to his stop valve to shut off the steam. On the other hand, the only two accidents to the governor that I can recall in my own experience were quite independent of the belt. In one case, in England, the governor had a direct or gear drive, and the key, being badly fitted, dropped out of the pinion on the governor spindle. The other case, mentioned in my "Reminiscences," was where the governor spindle stuck fast. In both these cases the engineer, not being hindered by the automatic rigging, was able to shut off the steam and prevent an accident. It will be observed that both of these accidents were caused by defective construction. After the first, I adopted the plan of raising the bottom of the keyway by a chisel, so the key could not fall out.

I never knew of a case of failure of the belt, although I can conceive it possible that an old, rotten belt, or one imperfectly united by some improved means, might fail. In my own work I always provided a flange on each side of the governor pulley, not because it might be necessary, but to allay the apprehension of anyone ignorant of the fact that a belt cannot run off from a crowned pulley.

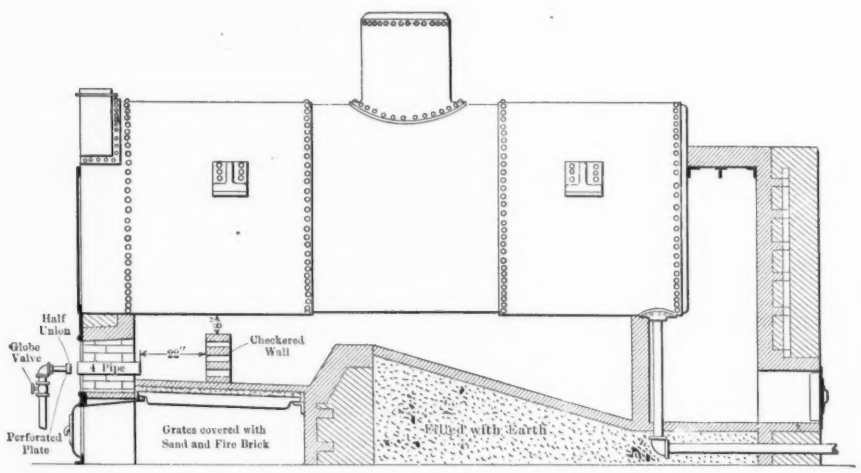
Of all the possible causes of failure of the governor, I think the belt would occupy the lowest place, while the automatic stop would stand at the top.

CHARLES T. PORTER.

Montclair, N. J.

Natural Gas Burner

The accompanying illustration shows a gas burner in use at our plant. It consists of a piece of 4-inch pipe, long enough to reach through the boiler front and arch and project 3 inches inside the furnace. It is cemented into the fire-door opening so as to be air-tight. At 22 inches from the end of the 4-inch pipe a checkerwork of firebrick is built to within 8 inches of the boiler shell, leaving a 2-inch opening between the ends of the bricks, the openings being staggered. I used a 1-inch pipe for gas and put one-half of a 1-inch union on the end, with a perforated disk and rubber washer in the union. The perforations are 1/32 inch in diameter, and as close together as they could be drilled. The union is about 3½ inches from the outer end of the 4-inch pipe.



BOILER SETTING ARRANGED FOR GAS BURNING

The grates are covered with firebrick and sand, to cause the air to enter the furnace through the 4-inch pipes with the gas. The air supply is regulated by a damper. I have one burner in each fire-door under a 70-horsepower boiler, and I am saving $4.50 per week in fuel, at 12 cents per 1000, over a perforated pipe burner which was in use at the time I took charge of the plant.

CHARLES W. FOSTER.

Fostoria, Ohio.

Simple Method of Determining Eccentric Keyway

Whenever it is required to replace the crank shaft of an engine by a new one, the usual method of laying out the keyways of the crank and eccentric is by transfering them from the old shaft. This is not always a safe procedure, since the keyways may be in bad condition.

A very simple and practical method, which is sure to be correct and time-saving, is shown in Figs. 1 and 2. The eccentric and crank are put on the shaft, and the whole placed on V-blocks as shown. Should it be inconvenient or impossible to nip the crank on the shaft, the center line *A B* may be described on the shaft and used as a substitute. This line must coincide with the center line on the crank when it is finally put in position. Next, set the center line of the eccentric *C D* at right angle to the line *A B*. The line *A B* being parallel with the surface plate *P*, the eccentric will now be in the correct position for a valve without lap and lead, the valve being in its central position.

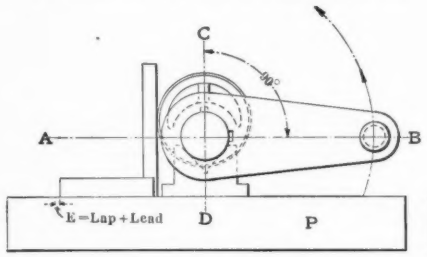


FIG. 1

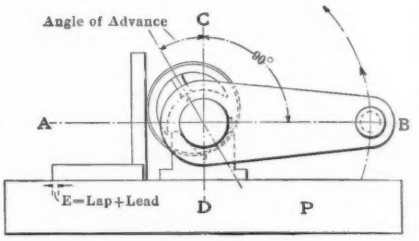


FIG. 2

Next, place a square in close contact with the eccentric, as indicated in Fig. 1, and mark off the distance *E* on the plate equal to the outside lap of the valve plus the lead. Then turn the eccentric *ahead* until the square coincides with the mark on the table (see Fig. 2). The keyway can now be scribed, since this is the correct position of the eccentric for that valve. A direct valve motion is considered here, but the same principle is applicable to indirect valve motions.

JOHN GASTEINER.

Brooklyn, N. Y.

Quarter Turn Belts

When about to put up a quarter turn, first ascertain the central point on the face of each pulley at the extremity of the horizontal diameter where the belt will leave the pulley. Then set that point on the driven pulley plumb over the corresponding point on the driving pulley. This will cause the belt to run squarely on each pulley.

This rule will render the setting of a quarter turn as easy as the setting of an ordinary straight belt.

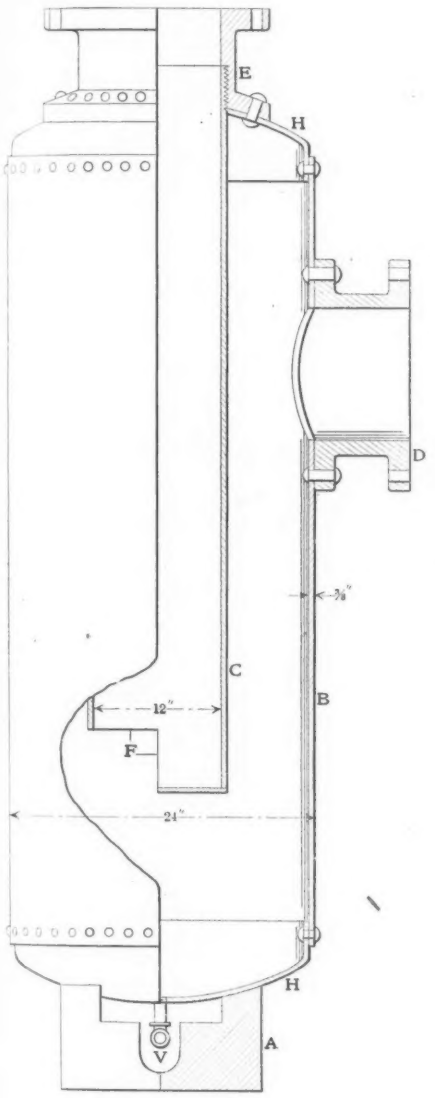
H. F. HOFFMAN.

Houston, Tex.

A Cheap Steam Separator

The principle of a steam separator is not very complicated, and the accompanying sketch shows how one engineer made one.

A pipe *B*, with an external diameter of 24 inches, was made of ⅜-inch metal. This was cut the desired length and two



HOMEMADE STEAM SEPARATOR

head pieces of ⅜-inch metal, shown at *H*, were shaped to fit into either end. At the top a hole was cut 10½ inches in diameter, to permit the steam pipe to enter. At the bottom a 1½-inch hole was tapped for a drain pipe *V*. Two special flanges were cast for the inlet and outlet pipes.

The casting *A* is a base for the separator. The bottom end of the 12-inch pipe *C* was closed at the bottom end and cut away as shown at *F*, to give an equivalent steam opening. As the wet steam issues from the pipe *C* it is thrown against the sides of the larger pipe, the water adhering to the sides and flowing downward to the drain pipe. As a further aid to separating the water, centrifugal forces are set up as the steam and water swing upward toward the outlet pipe *D*.

R. A. Anderson.

Preston, Cuba.

Factor of Safety

In the September 22 issue, page 494, L. W. Clark asks why, in my criticism of Joseph King's examination answers, I state that the factor of safety of the boiler without tubes or stays should be 8 instead of 5.

The idea of using a larger factor of safety for unstayed, flat surfaces is based on the fact that the strength or actual bursting pressure of unstayed, flat surfaces has never been sufficiently exploited; the experiments and practical tests have been few. Therefore, the recognized authorities have agreed that we should use a safety factor of 8, basing their opinion on the fact that the strength is always an uncertainty.

Mr. Clark states that Mr. King, doubtless, like some of the rest of us, is depending on others wiser than himself for information on this subject, and he is satisfied to accept opinions of recognized authorities in engineering matters. Don't for a minute think that I wish to pose as an authority, but Mr. King and Mr. Clark doubtless have the same opportunity I have to study the writings of men like Wilson, Kent, Rankine, Grashof, etc., all of whom are internationally recognized as authorities on this particular subject.

C. M. Hausen.

Pittsburg, Penn.

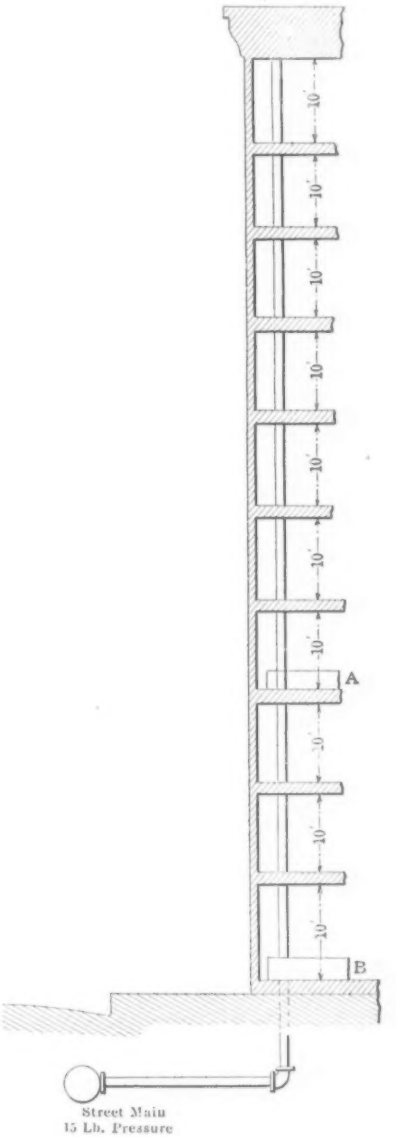
Pump Location

The following question was put to me in regard to setting a pump in a building: "Due to the fact that a pressure of 15 pounds per square inch will theoretically support a column of water 34.6 feet, would there be any advantage in placing a pump on the third story of a building if it were required to force water four more stories, each story being 10 feet high and the pressure in the street main being 15 pounds per square inch?"

The inquirer thought that placing the pump on the third story would only leave a head of 40 feet to be pumped against, whereas placing the pump on the ground floor would leave a head of 70 feet. *If* this were true, it certainly would be advantageous to place the pump as at *A* in the illustration. This is not the case, however, because the first 34.6 feet of head will be taken care of by the 15 pounds pressure in the main, no matter where the pump is placed, and, therefore, if we place it on the ground floor the head will still be 40 feet.

If the pump were placed 30 feet over the main, and for some reason the main pressure should drop considerably, then the pump might not be able to take water at all, and no water could be delivered to the upper stories of the building. If the system should become leaky between *A* and *B*, the hight through which the pump would have to suck would be increased. This would be similar to the decreased main pressure.

Another disadvantage is the increased cost of installation. The expense connected with the lifting of the pump to the third floor would be wasted money. A foundation is necessary for rigidity in order to prevent vibration, especially if



PUMP LOCATION

the pump is of the high-speed type. A pump so placed would in all probability be much farther away from the boiler (if it is a steam pump) than if it were placed on the ground floor. This would decrease the efficiency of the apparatus, and would, therefore, increase the running expenses.

H. W. Henes.

New York City.

Single Flywheel High Speed Engines

In reply to the question of Henry B. Hicks, page 408 of the September 8 issue, I wish to say that the engine in question has been in operation since November, 1903, and to date has given no trouble, and shows no signs of doing so.

Mr. Hicks says "the arrangement adopted must produce an excessive strain on the right-hand bearing." I deny this statement, as the absence of the left-hand flywheel can only produce two effects; to lessen crank-shaft pressure on the bottom of the left-hand bearing, and rob the engine of one-half of its flywheel steadying capacity. The horizontal strain backward on the right-hand bearing and forward on the left-hand bearing is not affected in the least by the removal of either flywheel.

R. MANLY ORR.

Brantford, Ont.

Careful Engineers

By careful engineers I mean men who are watching their work and paying attention to what they have under their charge. Only a few days ago I was in an engine room talking to the engineer as to whether a Corliss or a slide-valve engine would use the most steam in doing a certain amount of work, and he went on to tell me that a Corliss engine would use less than the slide-valve engine because a Corliss engine did part of its work from the expansion of steam, and that no slide-valve engine did any work from the expansion of steam, but took steam full stroke with no cutoff. Here was plenty of room for an argument, but I did not have any time to waste. There are too many engineers of this kind who are the cause of a good many accidents. Most flywheel accidents are caused through careless engineers who will let their engine run, knowing that the governor is out of order. An engineer should keep the governor of his engine in proper condition and not permit it to race so that the flywheels will leave the engine room. I know of engineers who permit their engines to run without the safety stop on the governor in operation.

All the safety appliances on the market would not do any good when under the care of an engineer like this. No doubt if an engine running under these conditions were wrecked by the bursting of the flywheel, and the engineer was left to tell the tale, he would say that he did not know the cause. If this type of engineer were removed from all plants and their places filled with careful engineers, there would not be so many accidents.

W. H. STIVASON.

Wilson, Penn.

Central Valve Engines

A number of English firms build the type of engine valve shown in Fig. 1, all more or less alike. The valve admits steam to the high-pressure cylinder between the rings. In the position shown the high-pressure piston is at the bottom of the stroke, and the valve has just

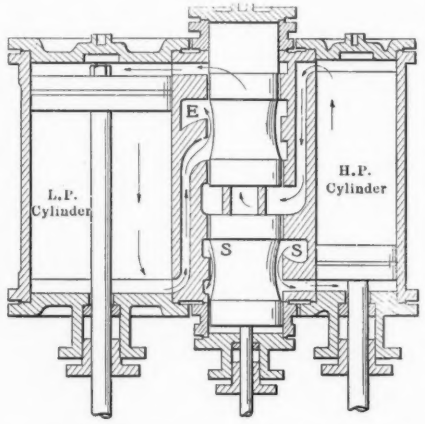


FIG. 1. DIAGRAM OF CENTRAL-VALVE ENGINE, SHOWING STEAM DISTRIBUTION

opened to admit steam to that end of the cylinder. The exhaust from the top side passes to the center of the piston valve and upward through it, entering the low-pressure cylinder over the top edge, which is just open to admit steam to the top side of the low-pressure piston. The exhaust steam is leaving the bottom end of the low-pressure cylinder, passing between the top rings to the exhaust port.

The diagram, Fig. 2, is from a "central valve" in use on three engines I am running. At *A*, *B*, *C* and *D* are cast-iron rings, the other parts of valve being of gun metal. The cast-iron rings are shown

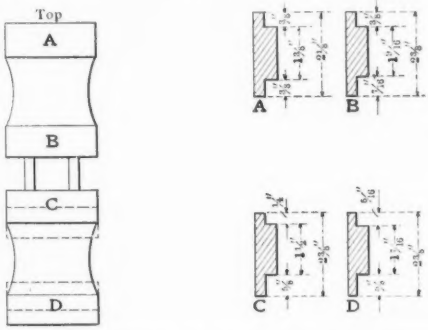


FIG. 2. DIAGRAM OF VALVE, WITH ENLARGED RING SECTIONS

in section in order to point out how easily the steam distribution may be affected by carelessness when fitting the valve together after overhauling. Sometime ago, on overhauling one of the engines it was found that the rings *C* and *D* had previously been put in upside down, thus giving extra lap to both ends, causing steam to be admitted late and cutoff earlier, and also giving exhaust lead, thus opening to the exhaust earlier and closing later. The correct positions of rings are shown in full lines, the wrong positions in dotted lines. This was the cause of the engine having to be overhauled.

In these engines the only way to examine readily for valve lead is to place the low-pressure piston on the top dead center and remove the valve cover, when the low-pressure port will be visible just the amount of lead there may be, and if the correct lead for this is known, if the valve has dropped, due to wear of the eccentric gear, it may be raised by inserting under the valve a washer of the required thickness to lift the valve to give the correct lead.

J. J. STAFFORD.

Birkenhead, Eng.

What Would You Do?

The question, "What would you do," asked in the editorial columns of the September 29 number, is one that I have debated in my own mind quite a number of times when I have known of engineers taking risks that I considered dangerous.

The answer to this question is another matter and would depend altogether on circumstances. We may say that we would not do a certain thing; we would leave the job first. But would we? Not so you would notice it.

There may be, and probably are, men who would not have operated the boilers named under any circumstances, but I doubt it. They may say they would not, but put them in the same position as those engineers and it is my opinion they would do likewise.

Here in Massachusetts we are supposed to have a law to protect the public, the plant owner and the engineer, but let an engineer file a complaint about the condition of his plant at the State House and see what will happen to him "mighty quick." He will be out on the street hunting another job and find it a hard proposition to connect with one. The first questions asked will be, "Where did you formerly work, and why did you leave there?" You tell the truth about the matter and it is one chance in one thousand of your getting the job.

I know of men who lost their jobs just because they kept hammering away at their employers to have certain repairs done that were actually needed because the conditions were dangerous. It is a fact that some plant owners will not do repairs until actually obliged to, in order to keep the wheels turning. I know of a plant where the engineer asked time after time for a new blowoff tank, as he considered the one in use dangerous. The plant owners could not see it. Result, the engineer started to blow his boiler down one morning and the tank gave way, scalding him so badly that he died. Verdict: He blew down his boiler under too high a pressure. Nothing was said about

the tank being strong enough to withstand any reasonable pressure.

We all take the risks, more or less, and there is no use denying the fact; it is human nature. I should say that I would do the best I could, if holding an undesirable position, and get another situation as soon as possible, in the meanwhile keeping an eye on the defect, not letting it get any worse, and also do a little missionary work with the owners. If I were in position where I had no one depending on me, it would either be repairs or a new engineer.

W. E. SARGENT.

Franklin, Mass.

Another Case of Flickering Lights

I should suggest to Mr. Carroll, whose letter appeared under the above caption in the October 20 number, the use of a potential regulator on the lighting circuit. These regulators may be made to operate by means of a small motor, or driven direct from the engine, and will serve to keep the potential on the lighting circuit practically constant through wide and sudden fluctuations of load.

Another method might be to choke down the current used when starting the elevator, compelling it to start more slowly, or if the motor is one which is in constant use, it might pay to have the motor running continuously, thereby doing away with the elevator-starting current.

The method of potential regulator seems to me best suited to the conditions, as it will serve not only to keep the potential constant under conditions as outlined, but also will take care of any other fluctuations which may occur, and serve to make the lighting operation thoroughly satisfactory. These regulators may be purchased from a number of the large manufacturing companies.

HENRY D. JACKSON.

Boston, Mass.

Boiler Explosion in Mississippi

The accompanying illustration shows the result of the exploding of one of six 60-inch by 16-foot return-tubular boilers, which were usually working together at Collins, Miss. On the evening prior to the explosion the two center boilers were cooled down and washed out. About 3 a.m. they had not succeeded in raising steam on these two and the fireman asked the night watchman to rake down some dry dust from the dust house, and at the same time told the assistant fireman to get up on the boilers and cut them into the header with the others. The watchman was in the dust house and lived to tell a part of the tale, but the two firemen were killed. The watchman says he was positive there was but little, if any, steam in these boilers, but the others had a good head of steam on.

WRECKAGE RESULTING FROM BOILER EXPLOSION

One of the boilers parted at the seams just over the first sheet. The front head of the boiler, with most of the tubes in it, went 1140 feet from the setting, strewing tubes all the way. Where the shell parted the sheet looked almost as if it had been sheared, there being very few rivets pulled out.

As the only ones who could enlighten us as to the cause of this explosion have been silenced forever, we have only our own speculation to draw from. It is evident that the assistant fireman was opening the valve into the header when the accident happened. He was found some 50 feet away tangled up in guy wires on the conveyer, with this valve still with him.

The boilers were carefully examined by the writer within two hours after the explosion, and they showed no signs of having been overheated. The tubes and plates were badly pitted, but not enough to have been termed dangerous for the pressure carried. It is, therefore, evident that water hammer caused the rupture when the valve was suddenly opened, and the inrush of steam from the header caused the destruction that followed.

The chief fireman was a man who had had at least seven years' experience, while his helper not much more than a boy, and was on his first job of the kind.

G. P. SLEDGE.

Collins, Miss.

Motor Troubles

Replying to the motor troubles of C. S. Norman, on page 663 of the October 20 number, I would say that in the case of the upper coils the force of gravity holds them with their angle strips against the shoulders of the pole pieces at all times, and thus no undue stresses are set up to break the strips. The lower coils, however, are held in place by the friction on the strips. Opposed to this is the force of gravity which tends to pull the coils away from the shoulders of the pole pieces.

The frequent stopping and starting jars the coil, which is not a perfectly rigid body, and lessens the force with which it is held up against the shoulder. The strong "magnetic pull" which the writer mentions then acts to force the coil up against the shoulder again. This produces a repeated stress at the corner edge of the angle strip just at the point where it is weakest, due to the cooling strains in casting.

It has been proved that a material may be ruptured by a repeated stress, one application of which would not be sufficient. If wrought-iron strips were used, on at least the lower coils, there would probably be no further trouble.

R. R. PRATT.

Brooklyn, N. Y.

Referring to C. S. Norman's letter concerning the breaking off of the cast-iron clips supporting the field coils on his motor, I would say that it is caused by magnetic vibration of the iron, which is produced by change of pull exerted on them by the armature coils passing the pole tips.

The reason the trouble occurs on the lower poles only is because the coils on these poles are loose enough to drop down away from the supporting end of the clips, allowing them to vibrate freely, and weaken at the bend sufficiently to break. The coils on the upper poles are resting against the turned-up ends, and so re-

duce the vibration that it does not weaken them to any extent.

I would suggest that Mr. Norman drive soft wedges between the turned-up ends and the coils. I think the trouble will then cease. These supporting clips should be made of hard brass.

S. KIRLIN.

Trenton, Tenn.

Safety Devices

In a recent issue I read two editorials entitled, "Preventing Flywheel Explosions" and "Do It Now." One speaks of the frequency of flywheel explosions and a possible preventive; the other, the consequences of neglect.

The first article notes the increasing number of flywheel accidents, and suggests the lack of proper vigilance on the part of some engineers in detecting faulty conditions, and that the usual blame is placed upon the governor, which lets the engineer down easy. The question is also asked: "Why did the governor fail to govern?"

Governors fail because they are automatic devices, and so much dependence is placed upon them, because of that fact, that they receive very little, if any, attention, and wear out and get out of adjustment, as automatic devices are bound to do if used constantly.

I have had a 500-horsepower cross-compound Corliss engine run away, although the safety pin and knock-off blocks were in proper position and everything was as it should be; but when the governor belt broke (by the way, it was laced with whang), the automatic stop failed to operate.

A peculiar thing about this engine stop was that without making any adjustments or changes, it was tried out in the presence of the superintendent and worked perfectly four times, but because of its absolute failure to operate when the governor belt broke we lost confidence in it as a safety device.

W. D. RANNEY.

Columbus, O.

Marine Condenser Repairs

Some time ago the engineers in an ocean-going vessel had considerable trouble with leakage in the main condenser, which was of the circular built-up type with castings at each end for water spaces. The tube plates were about 7 feet in diameter and more than an inch in thickness, there being about 2500 tubes, ¾ inch in diameter and 12 feet long. Upon arriving in port after each trip the condenser was tested in the usual way, by filling the steam space with water and examining the ends of the tubes in the water space through the small doors provided for this purpose. There was apparently only slight leakage, and this came from behind the division web of the after water space.

It was suspected that the leakage came from around the studs connecting the center of the tube plate to the web, and as it would have been quite a job to get at these, the engineers filled the space between the web and the plate with thin wedges and filled the corners with cement. On testing again there was no further leakage, so the condenser was closed up.

They had only been a short time at sea when the old trouble began again, and on their arrival in port the testing and patching with wood and cement were repeated. This continued for several trips until it was decided that it would pay to get at the cause of the trouble. The large doors were removed from the ends, and the tubes drawn out, as indicated by the dotted lines in Fig. 1, to permit a man to get down inside through the condenser to the middle. Then it was seen that the forward plate was supported by a strong back or dog, with studs connected to the outside door as shown at *A*, Figs. 1 and 2, the after plate being connected by four studs, to the center web of the after water-space casting, as shown at *B*. The two inner studs were quite loose in the web casting and were, therefore, useless as supports, and the outer studs were little better. The sea water had also eaten grooves around the holes in the tube plates where the studs passed through (Fig. 4). These facts accounted for the leakage under the primary test in port, the tightness on the second test and the leakage again at sea.

When filling the condenser in port the water trickled through the grooves around the studs as soon as it reached them, thus showing the leakage. On the second test the leakage would be stopped with the cement. On getting under way, the tube plate, being deprived of its support, would bend inward due to there being a vacuum on one side and pressure on the other, cracking the cement in the process. The studs would also come in as far as their loose condition would allow and the water could then flow around them into the condenser, Fig. 5.

After seeing the condition of the studs and tube plate the water-space casting was removed and found to be badly corroded around the stud holes as shown. The old stud holes were plugged as shown in Fig. 6. The web was cemented and squared up, and a filling piece fitted to it and secured by tap screws. The con-

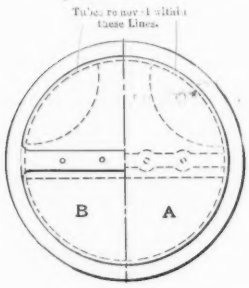


FIG. 1

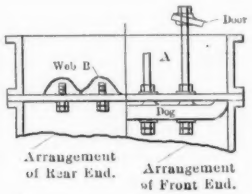


FIG. 2

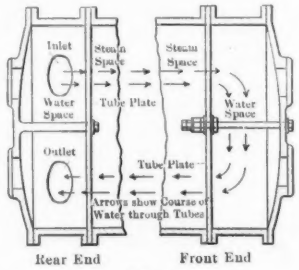


FIG. 3

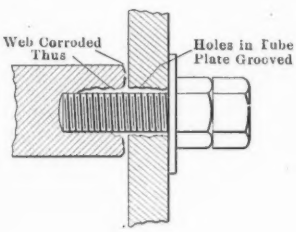


FIG. 4

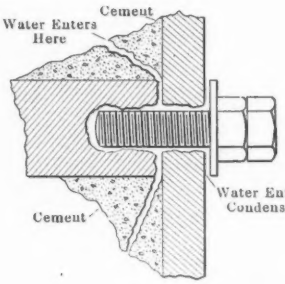


FIG. 5

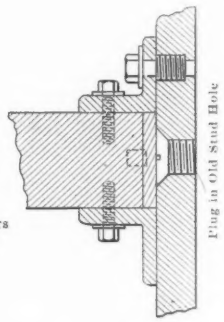


FIG. 6

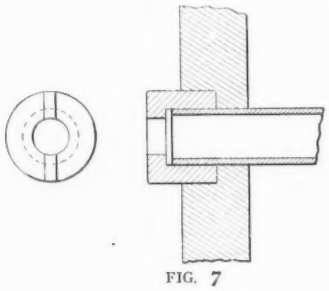


FIG. 7

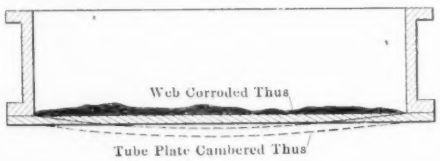


FIG. 8

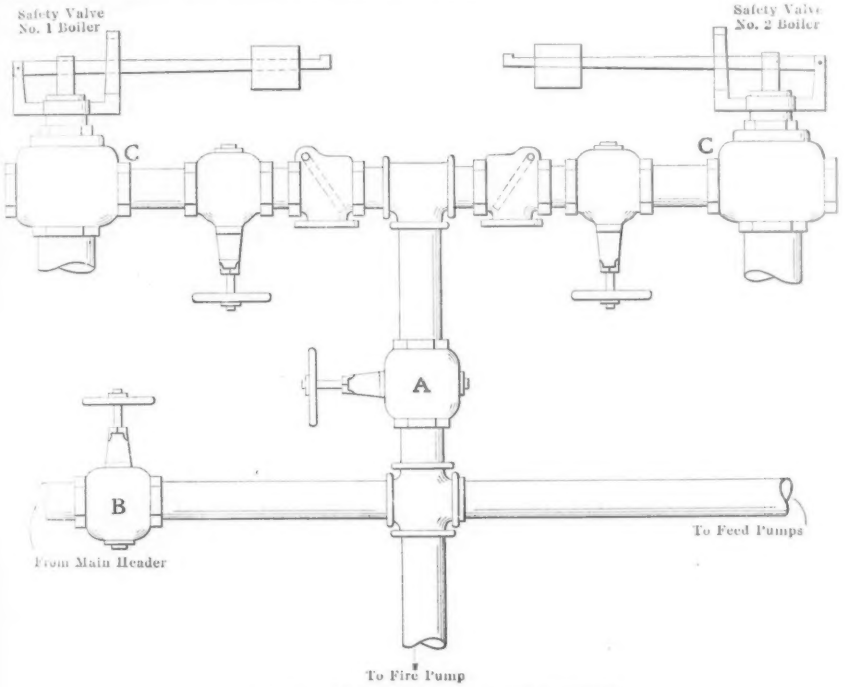
denser tubes were packed with cord and screwed ferrules (Fig. 7). Six of the ferrules with their tubes were removed above and below the web, and studs screwed to fit the spaces vacated. See Fig. 5. Angle irons were connected to the top and bottom of the web by studs and these were secured to the tube plate by the studs in the ferrule spaces, all the studs being staggered top and bottom to avoid local weakening of the web. After this arrangement was completed no further trouble was experienced.

J. M. Russell.

Antwerp, Belgium.

Bypass for Header

The fire underwriters consider it of the utmost importance that the steam pipe leading from the boilers to the fire pump should be as short and direct as possible and valveless, as a safeguard against the valve becoming closed, in case of fire. It is desirable, however, when making repairs, to be able to shut steam off from the main header by closing the stop valves on the boilers. The illustration shows the arrangement adopted in a large plant in Pennsylvania in order to obtain flexibility in this respect, without running the risk of ever having steam shut off from the fire pump.



HEADER AND FIRE-PUMP CONNECTIONS

When it is desired to shut steam off from the main header, valve *A* is first opened and then valve *B* closed. The fire pump and feed pump are then fed through the auxiliary connections *C C* under the safety valves of boilers 1 and 2. It is not possible to close valve *B* and forget to open valve *A*, because this would shut down the feed pumps, and would consequently be noticed immediately.

The connections *C C* were made at an otherwise useless opening in the casing of the safety valves, and they were provided with check valves as shown, to keep the steam from blowing back into either boiler in the event of an accident to a tube.

R. M. Hart.

Philadelphia, Penn.

Hydraulic Turbine Wear and Corrosion

At page 487 of the September 22 issue, Mr. Rushmore, in commenting on M. Dalemont's water-turbine researches, which I presented in abstract on page 180, suggests that corrosion of a wheel may result from the action of air brought out by the formation of a vacuum at certain places.

In M. Dalemont's monograph this very idea was advanced and opposed. Since the synopsis given did not fully present the passage referred to, I give below a literal translation.

M. Dalemont, himself, quoted from another writer, A. Waeber, who had suggested the formation of a vacuum, but as I understand M. Dalemont, he attempts to interpret Waeber's word "vacuum" (*vide*) as figuratively used to denote a region of dead water. In digesting the paper I followed M. Dalemont's construction and gave the following condensed version of the passage:

"The author cites another writer to the effect that such corrosion in a reaction turbine may result from the formation of an empty space or, to speak more accurately, a region outside the normal current and always full of eddies."

Below is a more literal translation of the words of Mr. Dalemont, in which the quotation from Waeber is comprised.

"There has been given to this wear the following explanation: 'At the beginning (the turbine adopted) was a limit [reaction] turbine, but after a run of a few months there was produced a strong corrosion in the movable blades, a damage resulting from the formation of a vacuum (*vide*) in certain places.' Evidently it is necessary to understand that this does not have to do with a vacuous space in the rigorous sense of the word, but with a region that remains outside of the normal current and which, as several writers have expressly indicated, is always full of eddies. Certain writers have attributed to these eddies no influence; in reality, at the place where they are produced, we observe abnormal erosions very deep and very rapid."

M. Dalemont says in a foot-note to the foregoing passage: "It is necessary to remark further that if the presence of air in certain parts of the moving vanes caused a rapid wear the turbine [under consideration] ought to be worn much more quickly since the wheel is a free-deviation [impulse] one. But, after eight years of service, the turbine is intact."

I hesitate to ascribe to M. Dalemont, on an obscure question, views which he might disown or explain away had he a direct voice in this discussion. Let it be said that his paper, in general, does not ignore the possibility of corrosion by air; much less does he deny chemical action of some sort as one of the plausible explanations of water-wheel pitting.

Edward P. Buffet.

New York City.

On page 487 of the September 22 issue, David D. Rushmore makes a statement which seems to me to contain so many original claims that it would surely be of great interest to many to know what actual facts and proofs Mr. Rushmore has to warrant the offering of his explanation on hydraulic-turbine wear and corrosion.

The statement I refer to is as follows: "Air which has bubbled through water, or rather the oxygen in the air which has passed through water, is not in ordinary condition, but is, for a short time, a conductor of electricity, indicating that the oxygen is in the nascent state."

The facts I would like to know are: What is the proof that air upon being taken from aërated water contains oxygen in the nascent state, and what is the proof that nascent oxygen is a good conductor of electricity?

If Mr. Rushmore will kindly answer this I feel sure that his reply will be of interest to many.

George P. Pearce.

Exeter, N. H.

A Peculiar Lighting Condition

The accompanying sketch shows the layout of the wiring of a station-lighting system which developed a peculiar condition of affairs. As will be seen, a portion of the lights remain permanently on the exciter busbar, while the remainder may be thrown on either the exciter or transformer, by means of the double-throw switch.

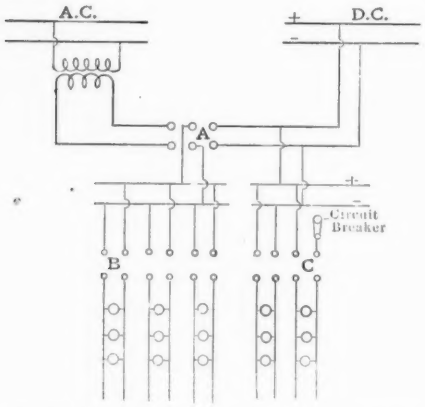


DIAGRAM OF WIRING FOR LIGHTING SYSTEM

A circuit *C* runs to the boiler-room gage lights, and to prevent blowing so many fuses through the boiler washer using bad extension-lamp cord, a circuit-breaker was installed on the negative side of the circuit, as shown.

Circuit *B* was installed at a later date and when put into service the peculiarity spoken of showed up. When all the lights are on the exciter, opening switch *A* will cause the circuit-breaker to fly open. With the switch *A* still open, the circuit-breaker may be closed again and will remain so until the switch *A* is closed and opened, when the breaker will again fly out. The lamps on circuit *C* will burn with the circuit-breaker open, if the switch *B* is closed and the switch *A* is closed on exciter busbar.

C. L. GREER.

Handley, Tex.

Natural Gas and the Earth's Revolutions

Some time ago W. D. Ranney raised the question: "Will not taking so much gas, coal and oil from the earth in time affect the motion of the earth or change its path in its travel around the sun, or change the climate?" and further asks: "Is it not possible that this old earth may forget to turn over some day, or that we are being drawn nearer to the sun each year because the earth is losing some of its buoyancy?"

Others besides Mr. Ranney have asked questions of this nature, and the answers are to be found in certain principles of physics which should be more generally understood than appears to be the case.

To begin with, the mass of all the gas, coal and oil that have ever been known to exist on this sphere is so trifling, compared with that of the remainder of the earth, that the entire removal of all of them from the field of its influence, if such a thing were possible, could only affect its relation to the sun in a degree that would be almost infinitely small. Furthermore, nothing that men have done has ever removed any particle of any substance from the earth, and it is at least highly improbable that any efforts they may make will succeed in doing so in the future. We may dig the earth and bring some of this material to the surface, thus changing the precise location, just as we may roll a stone from place to place, but it is still of the earth, and would be even though we found means to suspend it fifty miles above the surface.

Ages ago the sun's rays fell upon the earth and being absorbed by the vegetation of the period, have remained as potential energy in the coal seams, which is now being liberated by man to serve his own ends and purposes, but although we burn the coal, and profit by the immediate liberation of its heat energy, we do not lessen by one iota the amount of matter, and the energy also vibrates off into the atmosphere to again affect in varying degrees all matter which comes under its influence.

When the well drill strikes a gas pocket in the earth the gas will come to the surface, but though it escapes into the atmosphere, it has not left the earth, and even though we intercept and burn it, the matter, carbon, hydrogen, etc., of which it is composed is still with us, in changed form and different combination. Natural gas, being largely hydrogen, its combustion consists in great part of the combination of this element with oxygen from the atmosphere to form water, in the condition of invisible vapor at first, but which may easily be rendered perceptible by holding a cold, bright object, such as a new tin vessel, filled with cold water, above the flame, when drops of water will be seen to collect upon its surface to be re-evaporated again as the latter becomes warmed.

It appears to be assumed by many persons that a balloon or a vessel is rendered lighter, or as they say, "more buoyant," by being filled with gas, whereas just the contrary is true, the vessel is heavier by reason of the gas it contains and can only be lighter as the gas may have replaced a body heavier than itself, such as air. A balloon is not rendered buoyant by any magical quality of the gas with which it is inflated, but simply on account of the fact that the gas distends the bag and displaces an equal bulk of air, which is heavier than the balloon with its gaseous contents and the car with its occupants and apparatus.

As to the path of the earth around the sun, this is determined by its mass and by the speed with which it travels. The great mass of the sun attracts our sphere toward it, the centrifugal force due to the speed with which the earth travels tends to hold it away, and the path in which these forces are in equilibrium is the one in which the earth revolves around the sun. Should any influence materially retard the speed with which the earth travels, its mass meantime remaining unchanged, it would quickly be drawn toward the sun, and probably terminate its existence as a planet by being swallowed up by the great luminary.

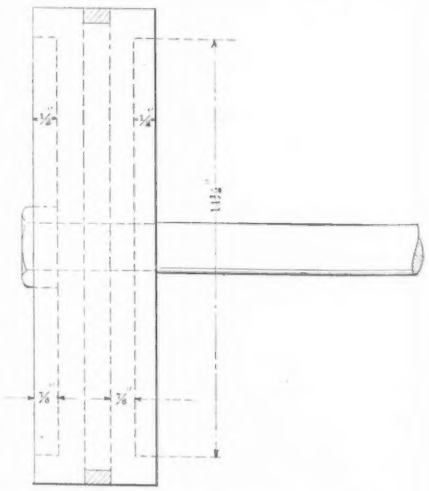
GERALD E. FLANAGAN.

Pittsburg, Penn.

A Poorly Designed Piston Head

An example of an error in the drawing of a piston head of a good make of engine is shown herewith. This head came from an engine having a 16-inch cylinder. It has a recess ½ inch deep and a diameter of 14½ inches, or an area of 165 square inches, which contains 82 cubic inches. This 82 inches of space is added to the steam clearance and in one revolution of the engine 164 cubic inches of steam is used wastefully. If this engine is running at 150 revolutions per minute 24,600 cubic inches of steam will be used in filling this space. This is for one minute; in one hour, it would reach 1,476,000 cubic inches.

One would not care to have a leak in a boiler allowing 82 cubic inches of hot



POORLY DESIGNED PISTON HEAD

water to escape per hour, but this engine is doing practically the same thing with this kind of a piston head. With all of the surface on the face of the cylinder as shown, only one sectional packing ring was used. It should have had two rings, considering the amount of room taken by the length of the cylinder. Our engines are wasteful enough at the best, without such fixed and continuous losses.

C. R. MCGAHEY

Lynchburg, Va.

Operating Steam Driven Air Compressors

Points the Engineer Should Be Familiar with, Such as the Arrangement of Cylinders, Functions of the Valve Gears, Speed Control, etc.

BY C. A. DAWLEY

The greatly increased use of compressed air in the past ten years has made the air compressor a familiar machine to most engineers, and since steam-driven compressors are in many ways similar to ordinary steam engines and are usually operated in connection with other steam machinery, it has followed that regular steam engineers have usually taken charge of running them and in most cases with good results. There are, however, a number of features of compressor operation which are different from ordinary engine practice, and it is to call attention to some of the special points which should be considered in selecting or running a compressor that this article is presented.

Compressors for ordinary air pressures of 80 to 100 pounds per square inch are now built with all combinations of simple or compound (two-stage) air cylinders and simple or compound steam cylinders.

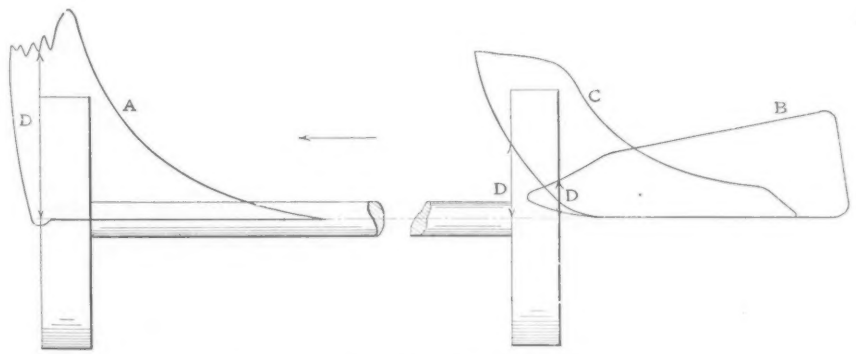


FIG. I. EFFECT OF HIGH COMPRESSION

As the use of air has extended over a wide variety of applications, and as the volumes of air and the power required have increased, the straight-line machine has been partially replaced by the duplex type, generally having compound air cylinders and often with compound steam cylinders also. This last combination, the "double-compound-duplex" is now the favored type for permanent plants and where the greatest economy of operation is desired.

Arrangement of Cylinders

In compressing air to 100 pounds pressure, there is a theoretical saving of about 15 per cent. in compound or two-stage compression, as compared with simple or single-stage compression. This is based on the indicated horsepower required in the air cylinders to compress and discharge 100 cubic feet of free air per minute. Of course, this theoretical saving is not all obtained, because in the compound cylinders the air has to pass through two sets of inlet and discharge valves instead of but one set in the simple cylinder, and it also passes through an intercooler formed of pipes which circulate water to cool the air between stages. In overcoming the friction due to the valves and intercooler and the extra piping, part of the 15 per cent. saving is lost, but there are other advantages of compound compression which make it at least 15 per cent. more desirable than simple compression provided it does not make the machine too complicated.

Straight-line machines are often built which have compound air cylinders in tandem, with a simple steam cylinder, and they have sometimes been built with compound steam cylinders, but this is not considered good construction in most cases. In the duplex compressors there are two steam cylinders and two air cylinders; the cranks are set at 90 degrees, so that one side helps the other over the centers, and it is evident that with this arrangement both the steam and the air ends may be compounded with no more cylinders and very little increased complication.

Steam-valve Gears

The steam valves used on air compressors are of the plain slide type, the Meyer riding cutoff, and the Corliss. Small straight-line and duplex machines generally have plain slide valves, as this is the simplest and cheapest construction. These valves are always set for a late cutoff for two reasons, first to prevent the machine from stopping in going over the center at slow speeds, and second to avoid an early opening and closing of the exhaust port. It is a property of the plain slide valve that an early cutoff can be obtained only by permitting an early release of the exhaust steam and an early closing of the exhaust port, which in turn results in high compression in the steam cylinder. In a mill or generator engine, compression is often desirable to cushion the piston and other moving parts and bring them to a stop gradually at the end of the stroke. This makes the engine run smoothly and quietly and is believed by some authorities to decrease the steam consumption. In a compressor, on the other hand, the air cylinders furnish more than sufficient cushioning, and if in addition the steam cylinders had a high compression, the machine would have to overcome the double pressure, which would increase the load on bearings, rods and frames besides requiring a heavy flywheel to overcome the resistance.

In Fig. 1 this point is illustrated, as applied to a straight-line machine; *A* is the air card at one end of the cylinder, *B* is the steam card at the opposite end of the steam cylinder, which is at that time driving the air out in the direction of the arrow. Card *B* illustrates usual conditions with cutoff at ¾ or ⅞ of the stroke and with corresponding low initial steam pressure. The card shows late release and practicallly no compression and very little lead; it would be considered an ordinary good card from a plain slide-valve compressor. The card *C* might be obtained with a plain slide valve designed for early cutoff. If we imagine this card as being at the opposite end of the cylinder from *B* and assume that the pistons have nearly reached the end of their stroke at *D*, it will be seen that the pressure exerted by *B* at position *D* is too little to overcome the air-discharge pressure at *D* on card *A* and the steam-compression pressure on card *C* at *D*. The flywheel would then have to carry the machine over against the heavy compression.

Owing to the late cutoff and resulting late expansion, compressors with plain slide valves make little pretension to economy. They are controlled usually by a throttling governor of the flywheel type, which throttles the steam down to a pressure which will maintain the speed constant as long as the air pressure does not exceed the desired limits. There is an air-plunger attachment to the governor, which still further throttles the steam and causes the compressor to slow down when

there is not enough air being used to keep the pressure below the point at which the governor is set.

Meyer Valve Gear

For the purpose of overcoming the defects of the plain slide valve in compressor service, the Meyer adjustable riding cutoff valve, illustrated in Fig. 2, is widely employed on compressors from medium sizes up to capacities of 2000 to 2500 feet per minute, where the Corliss type occupies the field. The action of this valve is the same as the plain valve having a late cutoff, but with the addition of a separate cutoff valve which seats upon the main valve, and consists of two adjustable plates mounted on right and left screws, so that by rotating the valve stem, the distance between the plates varies and the corresponding point of cutoff is changed. The cutoff-valve stem is connected to its eccentric rod by a ball-and-socket joint and carries a hand-wheel outside of the steam chest by which it can be turned. There is usually an index plate marked to show the point in the stroke at which cutoff will occur when the wheel is adjusted to the marks on this plate. The usual divisions are for ¼, ⅜, ½, ⅝ and ¾ stroke. When the index shows later cutoff than ¾, the steam is controlled by the main valve, and the riding valve does not close its ports. The adjustment of the cutoff wheel is made by hand, the intention being that in starting the machine the dial will be run out to the latest cutoff, and that after the machine has started, the engineer will run the cutoff back to ¼ to ⅜ stroke, which generally gives the best economy.

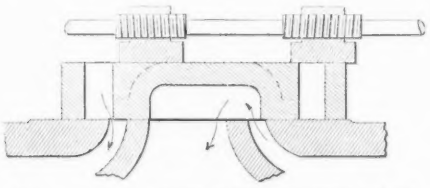


FIG. 2. THE MEYER RIDING CUTOFF VALVE

The proportion of the steam cylinders to the air cylinders is usually intended to be such that the necessary horsepower may be developed at ¼ cutoff. In a simple machine, either straight-line or duplex, this involves making the diameter of the steam cylinder the same as that of the air cylinder under usual conditions of steam and air pressure. When run at ¾ cutoff, cylinders of this size are, of course, much larger than needed to develop the required power, and consequently the steam has to be throttled down to a low pressure by the governor.

In running at a late cutoff, the steam used per horsepower is increased on account of the incomplete expansion and also by the reduced steam pressure. The action of this on the cards is shown in Fig. 3, illustrating how the steam pressure in the cylinder varies with the cutoff when the air pressure and speed remain the same. Card *A* is for ¼ cutoff, with maximum steam pressure admitted to the cylinder; *B* is for ⅜, *C* for ½ and *D* for ¾ cutoff. It is a frequent occurrence to have a steam pressure of 150 pounds in a plant where other engines are running, and at the same time have the compressors getting only 50 to 60 pounds in the cylinder. The increase in steam used per hour per horsepower is shown in curve *A* of Fig. 4, which gives the relative steam consumption of a compressor with simple steam cylinders, when producing the same air pressures and at the same speed, but with the cutoff at different points from ¼ to ¾ of the stroke.

Here is a detail of compressor management where a careful engineer can save his employer a large percentage of the coal bill, by giving attention to keeping the compressor at its most economical point of operation. The cost of fuel for a machine often equals the total price of a new machine in the course of a year's operation, 10 hours a day and a saving of 20 to 25 per cent. of this, which is easily obtained by watching the cutoff, is well worth careful attention.

It is not, however, always the fault of the man in charge that he does not run the machine under the best conditions. If the air demand is irregular, so that the speed varies widely, as is often the case, it is found especially with straight-line machines that they will stall at slow speeds and not start again unless run at late cutoff. This requires running out the valve wheel and barring the compressor over to restart, which is no easy trick, and it is only human nature that a man should try to avoid this annoyance by leaving the cutoff at the latest point. The duplex machine will seldom stop at slow speeds, unless the cutoff is earlier than ⅝ or ½ stroke. Another excuse for running at late cutoff is that it produces less strain on the machine, and, if the valves are unbalanced, it makes a decided reduction in the friction and the wear and tear on the valve gear. Whatever may be the merits of the possibility of running at an economical cutoff, the fact remains that probably not over 5 per cent. of the machines in service are so run and never will be until some one brings out a successful and practical machine which does this automatically. It is a safe venture that this is at the present time the most needed improvement in compressors between the limits of the plain slide valve and the Corliss valve gear.

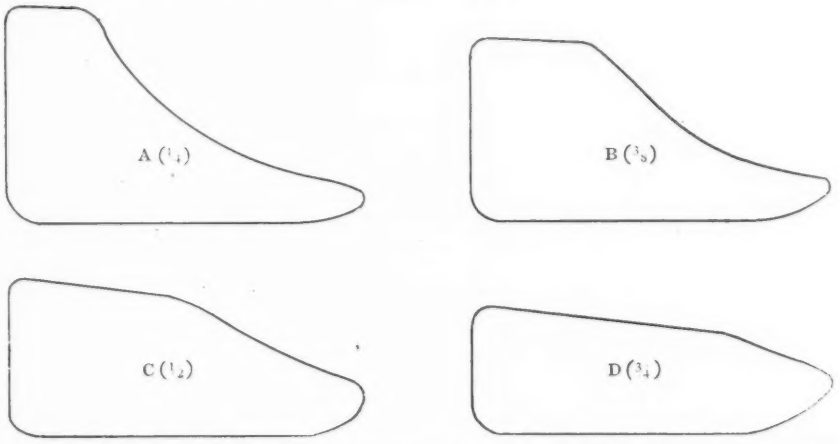


FIG. 3. VARIATION OF STEAM PRESSURE WITH THE CUTOFF, AIR PRESSURE AND SPEED REMAINING THE SAME

Speed Control

We have referred briefly to the method of governing speed. The air compressor has one property which is not usual in steam-driven machinery, namely, that the resistance is nearly uniform though the machine may be working at a small fraction of its total capacity. This simply means that it takes nearly the same number of foot-pounds to compress a cylinder full of free air, whether the machine runs slow or fast. Actually, the work is a little less at slow speeds, as the air friction and valve losses are less and the intercooling better, but in a machine of good design the difference between slow and full speeds amounts to only a few per cent. This steady load is also met with in pumping engines working against a constant head, but is not found in general power engines or electric-generator units, and even in the ammonia machine, which is a form of compressor, the work per stroke varies with the intake and discharge pressures, which, in turn, are controlled by the requirements of the material being refrigerated and the temperature of the cooling water.

The steam cylinders of the compressor will increase slightly in work per stroke as the speed decreases, on account of less resistance to the steam getting through the ports. As the air requires less and the steam cylinder would furnish more work at slow speeds, the result is that the steam is throttled more by the governor and a lower steam pressure in the cylinder will perform the work, but this lower steam

pressure does not decrease the amount of steam required as fast as the condensation of the steam increases it. Cylinder condensation, which consumes 20 to 30 per cent. of the steam used in simple cylinders at full load, may increase to double this amount at low speeds.

In Fig. 5 the curve *A* shows how the water rate increases at slow speeds in a simple compressor cylinder, when the position of the cutoff valve and the air-discharge pressure remain the same. The vertical distances on the curve represent percentages based on the best results obtained at full speed.

Where there is only one compressor, there is no way to avoid slow speeds at times, but in a plant having a number of machines it is important to keep only enough running to furnish the air required, when working near full speed. Some engineers prefer to use more machines and run slower, saying that they have less trouble with bearings, etc., and that machines last longer if run slow. This is undoubtedly true, but if a machine is well designed and built, its life will be a certain number of million revolutions, and the sooner these are run off, the sooner the machine will return its value to the owner. Certainly a saving of 10 to 20 per cent. on the steam used per unit of air furnished, is worthy of some effort to keep the plant operating at its highest efficiency. The uniform load above mentioned in combination with a proper speed, is capable of producing steam economies not exceeded by any class of steam engine.

Compounding

This uniform load is also a most favorable condition for compounding the steam cylinders. Many people think of compounding only in connection with condensing and complication, and it is undoubtedly true that in steam engines having an irregular load, the compound noncondensing engine has not much advantage over the simple. But in the air compressor the conditions of load are ideal for compounding, and, moreover, the losses attending late cutoff and slow speed are relatively much less in the compound. In curve *B* of Fig. 4, corresponding to curve *A* for the simple cylinder, it will be noticed that the steam required does not increase as fast at late cutoff as in curve *A*, which is shown by the distance between the two curves being greater at the ¾ mark than at ¼ or ⅜. Also in curve *B* of Fig. 5 it is seen that the speed variation does not affect the compound as much as the simple.

The proportioning of the cylinders of a compound is a matter of much complexity, involving the size of air cylinders, air pressure, steam pressure, types of air and steam valves, speed, method of governing, cutoff in steam cylinders and whether to be run condensing or noncondensing. Most of these can be known beforehand, and in a Corliss or automatic cutoff engine it is possible to get the best economy and also divide the work equally between the cylinders. In a Meyer valve-gear machine it is, of course, impossible to get the best distribution unless the cylinders are designed for some definite point of cutoff and used as designed. With the high-pressure cutoff valve set at any point, more work can be thrown onto the high-pressure side by making the low-pressure cutoff later, or if the high cylinder is doing too much work, it can be changed by making the low-pressure cutoff earlier and so increasing the receiver pressure which, in turn, puts more back pressure on the high cylinder and at the same time admits a higher pressure to the low. The compressor should be indicated and adjusted occasionally, noting the best points of cutoff and the corresponding steam and receiver pressures, so that the same conditions can be readily obtained when desired. If the machine is run at late cutoff or if a machine intended for condensing is run noncondensing, there is a chance of very uneven distribution of work and strains in the machine.

Corliss Compressor

In the compressor with Corliss valve gear is found the highest type of economical compressor and the one which should be used in most cases where permanent plants are to be installed and fuel is expensive. The Corliss compressor is usually operated condensing, because it is worth while to add a condenser to a plant of sufficient size and refinement to use a Corliss compressor. The Corliss

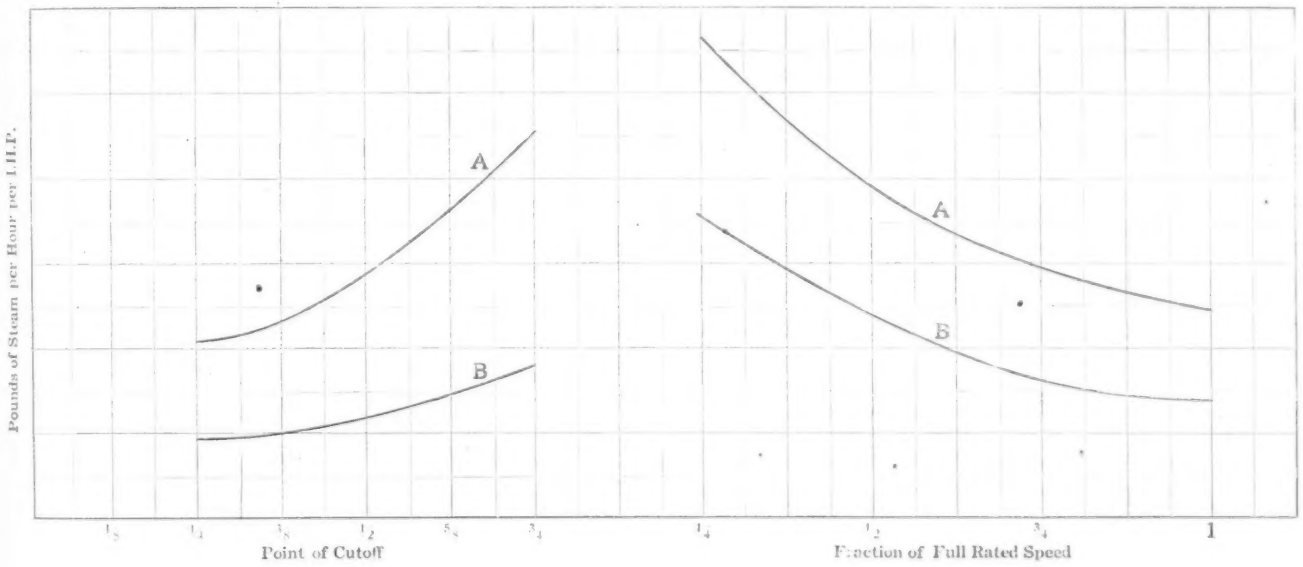


FIG. 4. RELATIVE STEAM CONSUMPTION AT DIFFERENT POINTS OF CUTOFF

FIG. 5. WATER-RATE INCREASES AT SLOW SPEEDS

machine is fitted with a combination speed and pressure governor operating the cutoff cams and making the machine automatic. Usually the governor acts on both high- and low-pressure valves at the same time, although if the low cylinder has a hand-adjustable cutoff, the regulation can easily be obtained on the high only.

The loss from late cutoff and throttling governor does not exist in this machine as in the plain slide- and Meyer-valve compressors, and the loss from running below normal speed is also relatively less. The Corliss compressor overlaps the field of the Meyer, beginning at about 1000 cubic feet per minute capacity (165 horsepower) and running up to sizes developing 1000 horsepower. Compressors of this type have made records in steam economy unexcelled by any similar steam engine.

The Anthracite Trust

The case of the Federal Government against the so-called anthracite trust of Pennsylvania has been followed with interest, not only by users of coal, but by students of economic conditions. The case was instituted in April, 1907, and has been continued recently in Philadelphia, New York and Scranton, Penn. The defendants are the railroad companies and coal companies of Pennsylvania dealing with anthracite, and the claim made by the Government is that these railroad and coal companies have combined to illegally restrain trade and in this regard have violated the Sherman anti-trust law.

The railroad companies involved, and known in the case as the defendant carriers, are the Philadelphia & Reading Railroad Company, the Lehigh Valley Railroad Company, the Delaware, Lackawanna & Western Railroad Company, the Central Railroad Company of New Jersey, the Erie Railroad Company and the New York, Susquehanna & Western Railroad Company, these companies all being engaged in the transportation of anthracite from the mines in Pennsylvania to the markets of that and other States.

The defendant coal companies are the Philadelphia & Reading Coal and Iron Company, the Lehigh Valley Coal Company, the Lehigh & Wilkes-Barre Coal Company, the Pennsylvania Coal Company, the Hillside Coal and Iron Company, and the New York, Susquehanna & Western Coal Company. All of these companies own and operate coal mines in the State of Pennsylvania and buy, sell and otherwise deal in anthracite in the markets of the several States. The Central Iron Company also owns and operates anthracite mines in the State of Pennsylvania, and the Reading Company is the holding corporation of the Reading System. It holds the entire capital stock of the Philadelphia & Reading Railroad Company and of the Philadelphia & Reading Coal and Iron Company and a majority in interest of the Central Railroad Company of New Jersey.

With the exception of a line operated by the Pennsylvania Railroad Company, one operated by the New York, Ontario & Western Railroad Company and the line of the Delaware & Hudson, which runs to northern New York and does not extend to tidewater, the defendant carriers operate the only lines of railroad that penetrate into the anthracite regions, and with the exceptions stated furnish and control the only means of transporting anthracite from the mines in Pennsylvania to the markets and distributing points in that and other States, particularly the great markets and distributing points at tidewater in the vicinity of the city of New York. Furthermore, as the Pennsylvania Railroad and the New York, Ontario & Western Railroad possess only a comparatively small fraction of the total number of collieries, the last named extending to but one of the four fields into which the region is divided, the defendant carriers furnish and control without exception the sole means of transportation from the great majority of the anthracite collieries to tidewater. In the year 1905 the total tonnage of anthracite transported from the mines was divided among the several railroads in the following proportions:

	Per Cent.
Philadelphia & Reading Railroad Company	20.48
Lehigh Valley Railroad Company	16.40
Delaware, Susquehanna & Schuylkill Railroad Company	2.61
Delaware, Lackawanna & Western Railroad Company	15.56
Central Railroad Company of New Jersey.	13.00
Erie Railroad Company and New York, Susquehanna & Western Railroad Company	10.14
Total	78.19
Pennsylvania Railroad Company	7.96
Delaware & Hudson Company	9.19
New York, Ontario & Western Railroad Company	4.66
Total	21.81

The franchises of the Delaware, Lackawanna & Western Railroad Company authorize it to own and operate coal mines in the State of Pennsylvania and to buy and sell coal as well as to transport persons and property as a common carrier, all of which it does, but the remaining defendant carriers are without lawful power under the constitution and laws of the State of Pennsylvania to operate coal mines or to buy, sell or otherwise deal in coal for profits. Nevertheless, they do so indirectly through the means and instrumentality of the defendant coal companies which they respectively control or which are controlled in their interest, that is to say, the Reading Company, the holding corporation of the Reading System, holds the entire capital stock of the Philadelphia & Reading Railroad Company, also holds the entire capital stock of the Philadelphia & Reading Coal and Iron Company, and the three companies have the same president; the Lehigh Valley owns all the capital stock of the Lehigh Valley Coal Company, and the two companies have the same president; the Central Railroad Company of New Jersey owns nine-tenths of the capital stock of the Lehigh & Wilkes-Barre Coal Company, and the two companies have the same president, who is also president of the Reading Company, the Philadelphia & Reading Railway Company and the Philadelphia & Reading Coal and Iron Company; the Erie Railroad Company owns all the capital stock of the Pennsylvania Coal Company and a large majority of the capital stock of the Hillside Coal and Iron Company, and the three companies have the same president; the New York, Susquehanna & Western Railroad Company owns nearly all the capital stock of the New York, Susquehanna & Western Coal Company, and the two companies have the same president, who is also president of the Erie Railroad Company, the Pennsylvania Coal Company and the Hillside Coal and Iron Company.

In addition there are other anthracite mining companies controlled by or in the interest of the defendant carriers, or at least some of them through the ownership of controlling stock interests. The defendant carriers and the coal companies controlled in their interests are for all practical purposes one and the same.

The source of the entire supply of anthracite, save a few small deposits of inferior quality, is located within the State of Pennsylvania, and the deposits extend over an area of only about 484 square miles, divided for trade purposes into three regions, namely, the Wyoming (sometimes called the Lackawanna region), the Lehigh region and the Schuylkill region, and for geographic and geologic purposes into four fields or basins, namely, the northern field, the eastern middle field, the western middle field and the southern field, the Wyoming region embracing the northern field, the Lehigh region the eastern middle field and the southern field east of Tamaqua, and the Schuylkill region the western middle field and the southern field west of Tamaqua. The defendant carriers and the Reading Company, either directly or through their subsidiary coal companies, own or control 90 per cent., approximately, of the entire unmined area of anthracite, distributed in substantially the following proportions:

	Per Cent.
Reading Company	44.00
Lehigh Valley Railroad Company	16.87
Delaware, Lackawanna & Western Railroad Company	6.55
Central Railroad Company of New Jersey.	19.00
Erie Railroad Company	2.59
New York, Susquehanna & Western Railroad Company	0.54
Total	89.55

Controlling this large percentage of the anthracite field, the defendant companies produce from 70 to 75 per cent. of the annual supply of anthracite. There are, however, a large number of independent or individual operators who mine anthracite either from their own properties or from properties leased by them. These independent operators produce approximately from 20 to 25 per cent. of the annual supply of anthracite, which would come in competition in the great distributing centers with the anthracite produced by the defendant carriers or their agencies, were it not for the unlawful contracts, combinations and conspiracies of these companies, which not only stifle competition between the several defendant carriers or their agencies in the sale of anthracite throughout the several States, but also between such defendant carriers and the independent operators.

The surplus output of anthracite, that is, that part of the output not consumed in the State of Pennsylvania, is carried chiefly to tidewater at New York harbor and is then distributed by water and by railroads to points in New England and the Middle Atlantic States, where the great bulk of the anthracite output is consumed. New York harbor is thus the

principal distributing point for anthracite, and, therefore, to fix or regulate the price of that commodity there, is to fix or regulate its price in the markets of the several States which get their supply through New York harbor points.

In January, 1892, competition between the Lehigh Valley Railroad Company, the Central Railroad Company of New Jersey and the Philadelphia & Reading Railroad Company in the procuration and transportation of coal, and between each of them and the Delaware, Lackawanna & Western Railroad Company, the Delaware & Hudson Canal Company and the Pennsylvania Railroad Company, each of which was possessed of interests in the anthracite region and the means of transportation therefrom, materially reduced the price of coal to consumers in New York and elsewhere to the loss of considerable profit to each of the companies named, which would not have been suffered if competition between them had not existed. The three railroad companies first named, which together owned or controlled 80 per cent. more or less of the anthracite deposits and transported 50 per cent. approximately of the total anthracite tonnage, attempted to combine and unite under a common source of control by means of certain indentures of lease, under which all the railroad and coal properties of the Lehigh Valley Railroad Company and the Central Railroad Company of New Jersey, the lessors, passed to the control of the Philadelphia & Reading Railroad Company for the period of 999 years. This long step in the direction of an anthracite monopoly was defeated, however, and the rule of competition restored.

The average price of anthracite at tidewater, taking for illustration the stove size, which rose from $3.71 and $3.85 per ton in 1890 and 1891, respectively, prior to the leases just described, to $4.15 and $4.19 per ton in 1892 and 1893, respectively, the years during which the leases were in force, again declined under the influence of competition in the years immediately following the cancellation of the leases, falling to $3.60 per ton in 1894 and $3.12 per ton in 1895. Whereupon the defendant carriers and coal companies, owning or controlling 90 per cent. of all the anthracite deposits, producing 75 per cent. of the annual supply and controlling all the means of transportation between the anthracite mines and tidewater, with the few exceptions mentioned, entered into an agreement by virtue of which they acquired power to control, regulate, restrain and monopolize not only the production of anthracite, but its transportation from the mines in Pennsylvania to market points in other States, and its price and sale throughout the several States, with the result that competition in the transportation and sale of anthracite has been wholly suppressed and the price to consumers greatly enhanced.

In addition, the defendant companies, in order to prevent the output of the independent mines from being sold in competition with the output of their own mines, entered into and now maintain an agreement or combination to use their power to obtain control of the sale and disposition of the output of the independent mines. Subsequent to 1892 the defendant companies made substantially uniform contracts for a term ending in 1900 for the sale of the independent output to the carrier or its coal company for a stated percentage of the average price prevailing at tidewater—55 per cent. at times and at other times 60 per cent. in the case of prepared sizes of anthracite, that is, all sizes above pea coal, and somewhat smaller percentages in the case of pea coal and sizes below that. At the expiration of these contracts new contracts were made containing substantially uniform provisions agreed upon beforehand by the defendant carriers, some of the operators contracting with one of the defendants and some with another, in which contracts the independent operators agreed to deliver all the anthracite thereafter mined from any of their mines now open and operated, or which they might thereafter open and operate, deliveries or shipments to be made from time to time as called for by the defendant carriers or their subsidiary coal companies, in consideration of which the defendant companies were to pay the independent operators for prepared sizes of anthracite 65 per cent. of the general average f.o.b. prices at tidewater points at or near New York, as computed from month to month, and for pea coal and sizes below that proportionately smaller percentages, declining as the sizes decline.

Taking for a basis the average tidewater price of anthracite at the time the contracts were made and during many years previous, the independent operators realized from 15 to 50 cents more per ton, depending upon the length of haul, etc., than was realized by the independent operator who shipped his coal to tidewater on his own account, paying the published rates of transportation himself and selling his coal in competition with the coal of the defendant carriers. This difference or advantage represents the amount per ton that the defendant carriers or their coal companies paid for the privilege of controlling the sale and disposition of the independent output, so as to prevent it from selling in competition with the output of their own mines. The result of this arrangement, as was intended, was to draw, if not to force, the great majority of the independent operators into making these contracts, enabling the defendant companies to control absolutely and until the mines are exhausted, the output of most of the independent anthracite mines. While the contracts were cast in the form of contracts of sale, in reality they are but mere devices to stifle competition and create a monopoly in the sale of anthracite.

This, in part, are the claims of the Government against the so-called anthracite trust, and enough has been said to give a general idea of the conditions existing. The testimony taken in the various hearings would appear to substantiate these claims.

Gas Power from Coke Ovens

By F. E. Junge

Enough has been said in previous articles on the utilization of waste gases and other combustibles in coal-mining and coke-making pursuits to establish the fact that by the adoption of gas engines one can gain from two and one-half to three times the power which it is possible to realize when coke oven or other gases are burned under boilers; also, that when the surplus power thus available cannot be utilized directly within the works it is in most localities possible to find profitable sale for high-tension electric current, generated with the gas power, within the neighboring districts of the works. The judicious operators of coke-oven and other plants which possess combustible materials that allow of more efficient utilization in gas engines and producers than is possible with the traditional means of steam-power generation will, therefore, take advantage of this development, realizing that power is money regardless whether outside markets must first be conquered for selling it.

Conditions are especially favorable if a colliery can establish connections with some central electric station to which it may contribute its share of surplus power at a constant rate of profit, at the same time being entitled by agreement to take energy from the line in cases of emergency, thus eliminating the costly reserves which would otherwise have to be installed in order to meet local breakdowns. The question then arises: Which method of valuation for these gases should be adopted? In the case of coke-oven gas, German practice differs considerably at different works. While it is universally conceded that these gases must be credited as having some value, and also that the cost of cleaning, if any, must be charged for them, the standard of appraising varies greatly in different localities. In some works the surplus coke-oven gases are valued at the same price as the illuminating gas from the city gas works (18 cents per 100 cubic feet). This is obviously too high. In others the gas is appraised according to its heat value, coal at local cost serving as the measure of comparison. When the price of coal at the works is $2 per ton and the calorific value of the coke-oven gas available is 3500 calories per cubic meter (392 B.t.u. per cubic foot), this mode of appraising would make its value equal to about 3

cents per 1000 cubic feet, which is the price that must be paid by the central station to the works management.

H. Bonte, Nürnberg, adopts this figure as the basis for estimating the total cost at the switchboard of one kilowatt-hour generated by coke-oven gas engines. He assumes that a colliery which has hitherto wasted its surplus power by insufficient equipment installs a 1000-horsepower gas engine and generator and establishes connections for the disposal of electric current with some overland central station. These large central stations, of which there are a number in Germany, act as a sort of electricity exchange bank, buying current from a number of individual contributors whenever and wherever they can get it at low rates, and selling it again to cities, railways and other industrial establishments at a profit. The small contributors to these stations, besides increasing their earning capacity, derive the advantage that they can operate their engines at a constant high-load factor, thereby securing the maximum possible income on the capital invested. Another advantage already referred to is that they need not install reserve equipment, since, in case of a breakdown in their power plant, they are entitled, by agreement, to take electric current from the common mains.

Assuming further that the 1000-horsepower coke-oven gas engine operates 6000 hours a year and that the initial cost of engine, piping, generator, switchboard, building and water-cooling tower is $55,000, or $55 per horsepower, then with annual interest on the capital of 4 per cent., depreciation of 10 per cent. (which is a liberal allowment considering that buildings and other parts are included in this price which do not depreciate so fast), and 1 per cent. for upkeep, or 15 per cent. altogether, the various items for one electric horsepower-hour figure out as follows:

	Cent.
Interest, depreciation and upkeep,	0.136
Cost of attendance.....	0.012
Cost of lubrication, waste, etc...	0.009

In addition, there is the fuel cost, which comes out at 3 cents per 1000 cubic feet with the valuation adopted above. With an average gas consumption per horsepower-hour of 24.7 cubic feet, the gas cost is 0.071 cent. Therefore the total cost for one effective horsepower-hour comes out at 0.23 cent, or for one kilowatt-hour 0.33 cent.

After having thus determined the total cost of operation of the proposed plant it remains to calculate the value of the electric current which is available for sale. This, of course, is strictly a matter of locality. But to give an example from German practice we will assume that the current will fetch a price of 0.7 cent per kilowatt-hour, which is extremely low. With this assumption the central station, which generates 6000 × 1000 × 0.67 = 4,000,000 kilowatt-hours, receives a remuneration of $28,600 per annum. The total operating expenses amount to $13,300, so that there remains a yearly surplus of $15,300. In other words, the initial capital investment, for one coke-oven gas engine and electric generator, of $55,000 yields an annual interest of 27.8 per cent.

In some densely populated districts of the United States the distribution and exchange of high-tension electric power developed from some cheap source of fuel, preferably from the waste gases and inferior grades of coal available in the iron and coal industries in the way described, is an undertaking which should be given serious thought by those whose interests would profit by an extension of central-station business.

There Is a Reason for Bad Pipe Fitting

By C. R. Strother

In the construction of small and medium-sized plants, it would seem as though pipe fitting generally receives the least amount of attention of any of the work. There are several reasons for this, one being that it is considered too expensive to employ a good and competent man to superintend the work, and another reason is just plain ignorance. In a small plant a purchasing agent has the authority to purchase all the machinery as well as the rest of the equipment, and he will probably lose sleep at night thinking over the plans and proposals in regard to which is the most suitable machinery to purchase, etc., but the pipe fittings and other little things escape his attention altogether. In fact, the writer has known of two instances where the pipe and pipe fittings were not ordered at all.

Now if one contractor "lands" the complete contract, that is, the engine, generator, boiler and the pipe fittings, there is a show for a good job of work all the way through, because the contractor will submit plans to the purchasing company for its approval, while if the engine was purchased from one company and the boiler from another, the generator from another, etc., there would be plenty of chance for a misfit and no opportunity for a set of plans to be prepared for anyone's approval. Of course, this doesn't apply to all plants, as there are exceptions, but to the territory around Charleston, W. Va., especially, where the method used to get steam, water and electric current to its destination is not considered

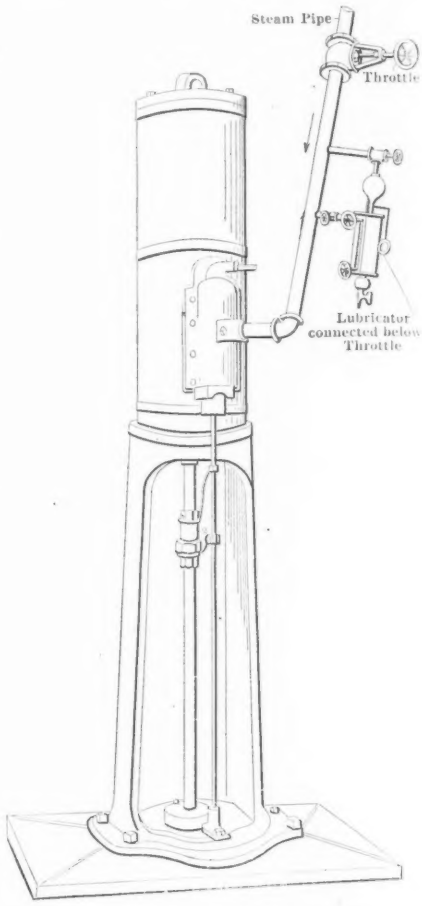


FIG. 1. BAD PIPE FITTING FOR DEEP WELL PUMP

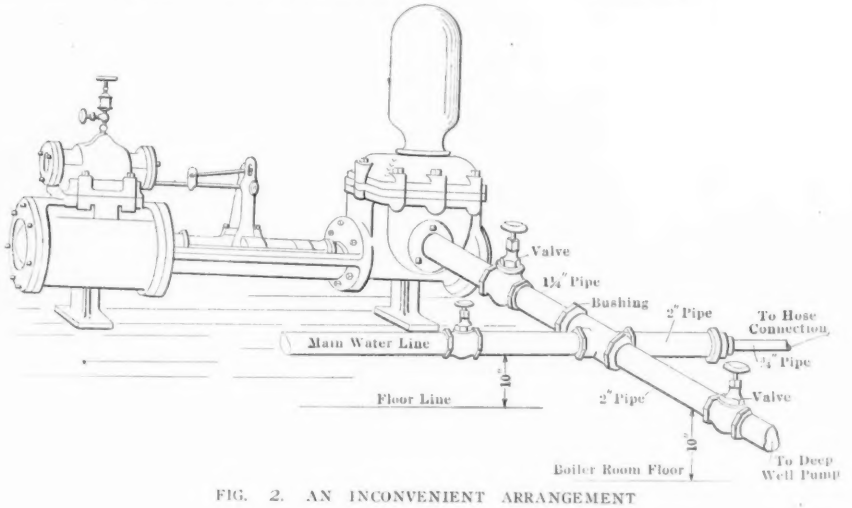


FIG. 2. AN INCONVENIENT ARRANGEMENT

at all, the question of what it is going to cost being the sole item of consideration.

As previously stated, the expense of an engineer to draw up a set of plans appears too great, as the purchasing party would say, but here is where a great mistake is made, because a competent man would save his salary several times over in pipe fittings and pipe, besides doing a better job, and in a more convenient way for the running engineer, or "day man," as he is called. So the pipe fitting is generally left to the day man, and only about one out of three knows anything about it.

A few illustrations will serve to show what careless jobs of pipe fitting actually

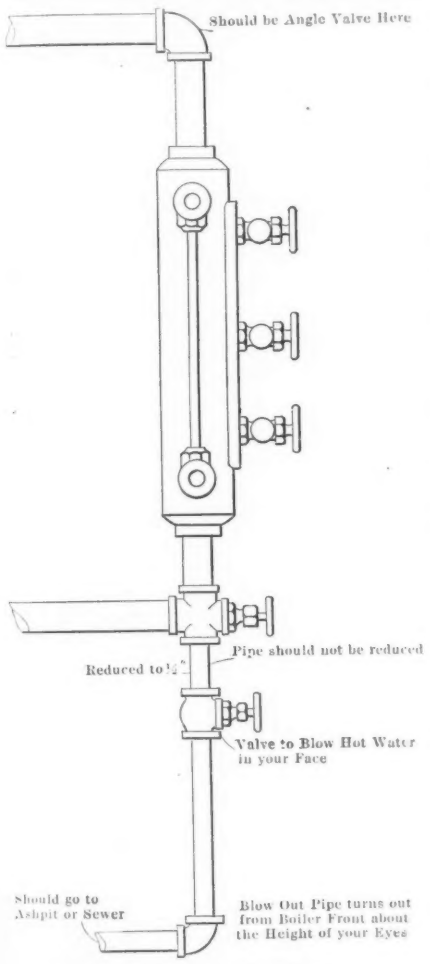

Should be Angle Valve Here
Pipe should not be reduced
Reduced to ¼"
Valve to Blow Hot Water in your Face
Should go to Ashpit or Sewer
Blow Out Pipe turns out from Boiler Front about the Height of your Eyes

FIG. 3. PIPING FOR A WATER COLUMN

exist and illustrate to some extent the conditions under which some engineers will work. In the plants from which the illustrations were taken, the writer took particular pains to inquire of the engineer as to whether he was taking any engineering paper. One out of the five men thus questioned was taking POWER AND THE ENGINEER, this man being responsible for Fig. 2.

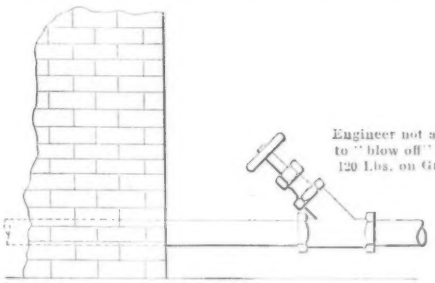
Of course, there may be some good engineers who do not take engineering papers, but the appearance of the plant generally tells the story.

Some of the pipe fittings shown in the illustrations have been in operation for two years to the writer's knowledge and have certainly caused a good deal of inconvenience, yet about the only reason that can be given as to why pipe fittings of this kind are not changed, is ignorance, no ambition and watching the clock.

Fig. 1 shows a method of piping up a lubricator on a deep-well pump. While there is no serious trouble likely to arise from the method, its appearance is enough to condemn the engineer for not changing it, and for not making the lubricator connection above the throttle instead of below.

Fig. 2 shows a method of piping up a boiler feed pump. Instead of the pipe being close to the floor, it is about 10 inches above the floor, which makes it very inconvenient in passing, and, if the intake is 1¼ inches in diameter, there is no use of having the bushing in the cross.

Fig. 3 shows how a water column was connected up. An angle valve should replace the top ell as it would be more convenient, for when a water glass breaks, it is a case of hunt up a ladder and climb over the top of the boiler, or if it is impossible to get over the front, then the ladder will have to be moved to the side, and by the time the ladder is found and placed, the boiler room will be full of steam. Also, it is not good practice to reduce the pipe to the blowoff, for to dislocate any sediment or scale which may form in the column, it is necessary to get all the pressure possible in order to blow it out. The blowoff should connect with the sewer or ashpit, as it is not very desirable to blow the water in your face. Water columns are frequently neglected and not blown down often enough, yet it is wondered why they give so much trouble.



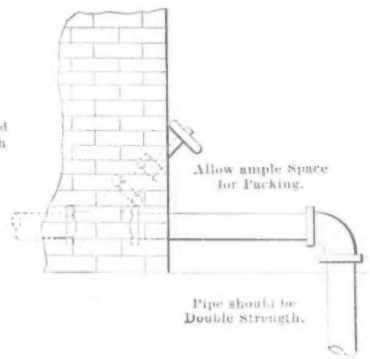


FIG. 5. INCORRECT AND CORRECT METHODS OF PLACING "Y" BLOWOFF VALVES

Fig. 4 shows a globe valve between the boiler and the safety valve, and its use is a matter of considerable doubt. This illustration was found on a boiler in an old abandoned plant, and the valves were as shown in the illustration.

Fig. 5 shows a method of placing a Y blowoff valve which is evidently wrong, as an ordinary globe valve would answer the purpose just as well, if connected in the same place as the Y valve. The sketch at the right shows the correct way of placing the Y blowoff valve. The reason the valve is so made is to enable it to be placed in the boiler wall in order to keep it from freezing and still make it accessible for packing and for opening and closing.

To Prolong the Life of Driving Belts

To attain this object the outside of belts should be lubricated with pure whale oil and tallow. After work has been stopped in the evening the belts are well cleaned with a brush, to be lubricated next morning. If this be done every ten weeks the inside of the belt need not be lubricated, except if it should slide on the pulley. Having been lubricated on the inside the belt will probably still be sliding,

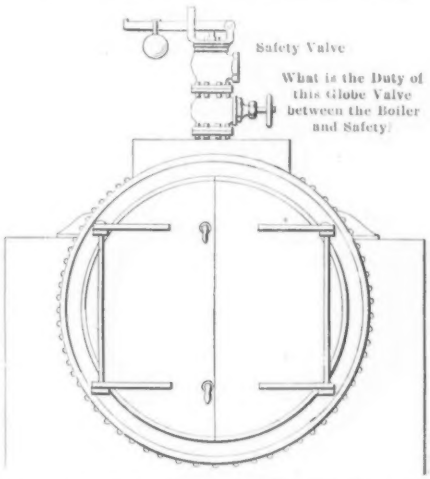


FIG. 4. GLOBE VALVE BETWEEN BOILER AND SAFETY VALVE

but as soon as the lubricant has been absorbed by the belt it will shrink and its driving power increases. Avoid using resin, colophony, pitch, wax, tar, etc., as these substances harden the belt and soil the pulleys. The belt should be stretched before being placed on the pulley: Suspend it from the shaft and gradually increase the weight placed in the lower loop. The tension thus caused should be five times the ordinary tension when working. When the belt has been running 3 to 4 weeks it no longer needs stretching. It should not be running on the pulley too tight, to avoid heating the journals. When not working, throw the belt off the pulley. —*Werkmeister Zeitung.*

POWER AND THE ENGINEER

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Monopoly in Anthracite

The case of the Government against the carriers of anthracite and their subsidiary coal companies, briefly stated elsewhere in this number, should make interesting reading for the producer of power, light or heat, using anthracite as fuel. A careful investigation by the Government has brought forth the information contained in the article, and there is every reason to believe that the claims made are accurate in every respect. This being the case, the defendant companies have violated the Sherman anti-trust act, in spirit at least, and by means of their combination have raised the price of anthracite to a figure considerably above that which would exist under normal competition. The trial is progressing and in all probability the Government will complete its case within another month, when the defendant companies will have their turn. What the outcome will be is doubtful at the present writing, although the case has been ably presented by the Government lawyers. Statistics prepared by the various defendant companies show that the stocks of the railroads and coal companies are owned much in common, that the same men are presidents of both railroad and coal companies and that the sixty-five per cent. contracts with the independent owners actually exist. From evidence during the hearing it was brought out that an exhorbitant freight rate of $1.60 per ton was charged for transporting anthracite from mine to tidewater, with the evident intention of putting the independent owners at a disadvantage in meeting the tidewater price of the combined companies. With the defendant carriers and coal companies practically one and the same thing, the high freight rates would, of course, not affect the combination. It was also shown that the defendant companies charged the same price for coal, and that it was common practice for all to make an annual drop in April of fifty cents per ton, and every month thereafter, until September 1, to raise the price of anthracite ten cents per ton, all this tending to show a mutual agreement instead of open competition between independent companies. These various points make it virtually certain that a general agreement does exist and that the defendant companies have combined to regulate the production and control the sale of anthracite. The chief difficulty is to obtain proof to this effect which will hold in court. The agreements made between the various companies have never been formal, but were rather the arrangements of gentlemen made in an after-dinner talk. The Sherman anti-trust act went into effect in 1890, some time before the present combination, and with such men as Morgan and Baer behind the scenes, the arrangements were in all probability made with the greatest care to avoid violating this law from a technical standpoint. This, of course, is mere supposition, and to arrive at definite conclusions it will be necessary to watch developments in the trial. For moral and economic interests the Government should win and restore to the consumer of anthracite the advantage of a charge per ton lowered by free and active competition.

Burning Water

In the very near future the public may expect to be invited to invest in the capital stock of a corporation formed for the purpose of burning water. Water being a chemical combination of hydrogen and oxygen in the exact proportions of a perfect fuel, the problem of dissociation presents such attractive features that one is almost inclined to forget that the recombination of the elements of water will not give up more energy than is required to separate them. To know that a pound of hydrogen holds sixty thousand heat units and has a theoretical possibility under perfect conditions of evaporating 62 pounds of water from and at 212 degrees Fahrenheit, or, exploded in the cylinder of a gas engine, may do more work than three pounds of gasolene, fathers the wish that some cheap and efficient method of hydrogen production may be discovered.

That the search for this method has resulted in success is the claim of one Edward C. Warren, "master mariner, engineer and scientist," who with his new hydrogen motor expects to revolutionize present-day methods of power production, to close the coal mines of the world, to drive the wheels of industry at a higher rate of speed and to send the "Lusitania" across the ocean in seventy-two hours, or less. The water from which the new fuel will be derived will be taken in at the front of the boat and, after being burned in the motor, in the cook's galley, and in other places where needed, will be dropped astern, ready to be picked up by the "Mauretania," and again be made to serve commerce, minister to the wants of man and the desires of the high-speed fiend.

Mr. Warren is quoted as saying: "That hydrogen may be manufactured from water by more or less complex and expensive processes has been long known, but my process is the first by which it may be produced economically and utilized in an engine or motor."

Mr. Warren's process, like all others where a weight is made to utilize the force generated by falling from a certain hight to lift itself to a hight greater than that from which it fell is, of course, a secret one, but it is as if Niagara could be made to develop power enough to pump itself back up to the level from which it fell, beside furnishing power for light, heat and other purposes. This, of course, will be quite easy when the grip

in which oxygen and hydrogen are held in the form of water can be broken by the expenditure of less energy than that with which they will rush together. Captain Warren's scheme is an attractive one, but all rose-colored statements of wonders to be accomplished may safely be taken with the proverbial grain of salt.

Standard Flanges when Tongued and Grooved

The question has arisen whether a standard flange may be turned off so as to leave a tongue, or cut into so as to form a groove, and still be standard. Some designers insist upon the face of the flange being cut away, leaving a raised face inside of the bolt circle. Is a standard flange, which has been so cut away, a "standard flange?"

It is probable that it would not be so regarded, and that a strict interpretation of a contract calling for "standard flanges" would support the contention that the thinnest portion of the flange, the portion below the bottom of a groove, or below the base of a tongue, or a raised face, should be of the standard thickness. At the same time standard flanges cut away to form the tongue or raised face, or cut into to form the groove ordinarily called for when these kinds of joint are wanted, are strong enough for many, if not most purposes, and can be furnished considerably cheaper than as though special castings had to be made. The designer or purchaser should be made to understand the difference. He will usually accept the standard flanges turned off, or cut into, rather than pay the extra price for the specials, but this understanding should be effected at the time of making the contract, otherwise, if cut-down standard flanges are furnished when standard is specified, the purchaser may be able to support the contention that the specifications have not been complied with.

Products of the Culm Bank

The engineer engaged in burning anthracite generally does not doubt that his coal comes directly from the mine, when in reality it is often merely the product of the culm bank and may have been mined years previously. In the early days of mining anthracite considerable coal was wasted, as immediate profits were all that were wanted by the operators, who leased the mines for a short term of years and paid a royalty on such coal as was actually marketed. The consumer demanded large-sized coal, and such was furnished. No attempt was made at that time to educate the consumer to the use of smaller sizes. For these reasons the culm banks grew, running over acres of ground, destroying vegetation and adding to the general barrenness of the mining region.

This enormous waste continued for years, until the mines were absorbed by larger interests having both the means and incentive to bring about a more economical use of this valuable commodity. This was accomplished in part by the commercial introduction of smaller sizes of coal, and the education of the consumer in the use of the grades known as "pea," "buckwheat," "rice" and "barley," which sizes are being successfully burned in steam-plant boiler furnaces today.

The amount of coal, slate and dirt dumped on the culm bank from the commencement of mining operations up to 1903, at which time the enormous value of these waste products began to be realized, was estimated as 315,700,000 tons, or 35 per cent. of the total production of coal during that period. Statistics show that during 1903 the shipments of reclaimed coal from the washers amounted to 3,677,099 tons, or 5.92 per cent. of a total amount of coal marketed during the year. These figures show the extensive waste which was permitted to occur from year to year, and also the enormous profit present mine owners are making from these now valuable culm banks.

Not only is the fact that such a large amount of abandoned fuel is being reclaimed of interest, but the process of conveying, washing and separating the coal, slate and dirt appeals to the engineering mind. The operation is simplicity itself, and when its value is realized one wonders that such a waste was ever permitted to occur. The culm bank stands many feet high and, therefore, it is a simple matter for a man with a hose to flush the culm into a conveyer, which conveys it to the top of the washery; a stream of water 2½ inches in diameter being sufficient to carry the culm to the conveyer, which in some instances extends one thousand feet from the washery. As some of these washeries have a capacity of one hundred and twenty tons of washed coal per hour, some estimate can be made as to the amount of culm handled per month.

The first operation after the culm passes into the washery is the breaking up of large lumps of slate and coal into small pieces, and throwing out the slate and other foreign substances. The coal is then fed through a series of shaking screens of the flat-shaking type, driven by eccentrics and so set that the screens receive the thrusts alternately, thus preventing undue vibration through the building.

As soon as it passes upon the first screen the material is sprayed with water. This screen contains holes 1½ inches in diameter, through which the chestnut and smaller sizes of coal pass. The lower portion of the screen contains 2-inch holes, through which the stove size of coal falls. This same operation is carried out with the larger sizes of coal. As the coal passes through the holes in one screen it falls to the one directly underneath and either passes out through the chute at the lower end, or falls through the screen to the next smaller size below. This process is continued until the smallest size, or barley coal, has been reclaimed. The dust and fine coal are then carried to a settling pond or conveyed to abandoned mines.

Effect of Forcing on Steel Boiler Plate

In view of the present tendency to get increased capacities out of boilers, the following, by Carl Sulzer, appearing in the Foreign Abstracts of the *Journal* of the Institute of Civil Engineers, will be of interest. It should be said, however, that clean plate should be able to transmit heat at a greater rate than this without trouble.

"Much discussion has arisen respecting the cause of the production of cracks in metals by heating, and this is especially the case in boiler work. The case cited in this article is that of a Cornish boiler 30.6 feet long and 6.56 feet in diameter for a working steam pressure of 105 pounds per square inch, and a test pressure of 180 pounds per square inch. It was built by Sulzer Brothers, of Winterthur, in 1899, and the material used was Siemens-Martin mild steel. Tests of the plates at the rolling mills showed an average breaking load of 23.45 tons per square inch, and an average elongation of 30.1 per cent. The chemical analysis showed the carbon to be 0.048 per cent., and the boiler was built in the best manner with all rivet holes drilled in position after the plates were bent, and the rivets were closed by hydraulic pressure.

"The boiler was put to work in January, 1900, and was used regularly from that date. A number of leakages showed themselves in 1905, and far worse ones in 1906 and in February, 1907, and all these were stopped by calking. In April, 1907, they became so bad that calking was useless. Careful inspection showed cracks in the circumferential seams of the shell plates which necessitated a new shell. It appeared that the boiler had been very much forced, as much as 8.2 pounds of water being evaporated per square foot of heating surface per hour, which is nearly double the rate allowed by the makers. Cleaning was done very rapidly and the boiler set to work again at once, so that the changes in temperature were very great, but it did not appear that excessive scale had been allowed to form. Illustrations show what serious cracks had been formed between adjacent rivet holes. Test pieces cut from the defective parts showed that the material was still as good as when first used, and the author concludes that the damage was not caused by the internal steam pressure, but solely by the excessive heating of the external shell plates through undue forcing and very heavy firing."

Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

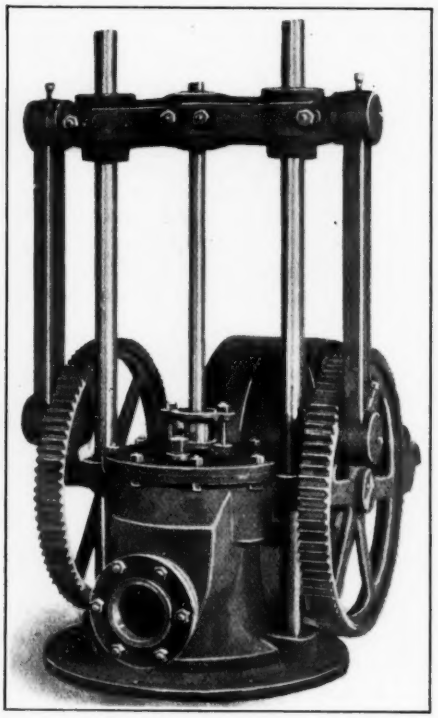
MUST BE NEW OR INTERESTING

"Bulldozer" Working Head

The new "Bulldozer" power working head is built to transmit power directly from the belt pulley through two lines of gears to the piston rod. By this construction the side arms are almost in line with the piston rod on the working stroke, relieving the machine from all side strain and decreasing the liability of breakage.

The crosshead is made in halves, and by removing four bolts may be laid back on the belt pulleys, together with the side arms, permitting the piston rod and plunger to be drawn up through the head of the pump without disturbing the belt or pipe connections. The crosshead guides are steel shafting well supported by lugs at the top and bottom of the base.

The suction pipe is supported on a separate collar placed directly under the stuffing-box cap, and may be removed without disturbing the discharge pipe or belt connections.



"BULLDOZER" POWER WORKING HEAD

The working head, as illustrated, is designed for a 24-inch stroke, with a suction pipe up to 8 inches and a discharge pipe up to 6 inches. It is fitted with tight- and loose-belt pulleys.

This working head is manufactured by F. E. Myers & Bros., Ashland, Ohio.

The Hammond Water Meter

This is a new meter for measuring water and other liquids. The exterior construction of the meter is shown in Fig. 1, and a sectional view is shown in Fig. 2. Its operation is as follows: The meter consists of a receiving tank *A* and a measuring tank which is divided into two compartments, *B* right and and *B* left, by the partition *C*.

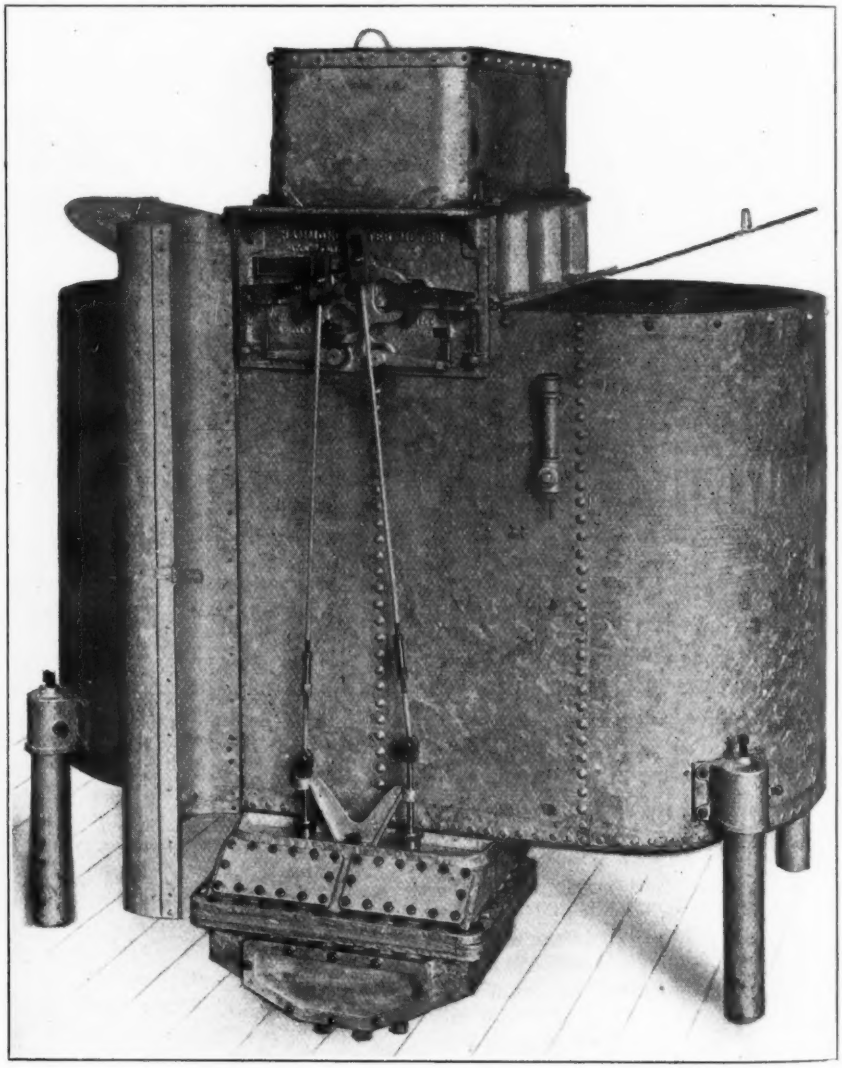


FIG. 1. HAMMOND WATER METER

The liquid enters the receiving tank *A* at the inlet, and flows through a slot in the bottom to the measuring tank *B*, in which are placed the discharge valves *D* and *M*, opening downward from each compartment, and held up to their seats by the valve rods *E* and *O*, which are attached to the wristplate *F*. The inlet valve *G* is connected to the wristplate on the same shaft.

Assuming the inlet valve *G* and wristplate *F* to be in the position shown, and the water flowing into the left side of the measuring tank *B*, the discharge valve *D* is held up to its seat by the wristplate *F*, which is held by the latch *H*. As the water rises in this compartment it lifts

the float *I*, which, through suitable connections, unhooks the latch *H* and releases the wristplate. The weight of the water on the discharge valve *D* instantly pulls the valve down and rotates the wristplate. This turns the inlet valve *G* to deflect into the right side of tank *B*. At the same time it draws up the discharge valve *M* to its seat, where it is held up by latch *N*, ready for the water now flowing into the right compartment.

There is a spring at *J* in the head of the valve rods *E* and *O* which hold the discharge valves up to their seats and keep them from leaking. The wristplates and latches are provided with hook blocks similar to those on the valve gear of a Corliss engine, and are made of hardened steel.

The operation of the meter is automatic and continuous. A record of the cycles of operation is tallied on a revolution counter *K*. A gage is shown at *L*.

It will be noted that the work of shifting the valves is done by the weight of the water on the discharge valves, and not by the floats, which have only to trip the mechanism, and are, therefore, very sensitive. The movement of the mechanism is almost instantaneous after the float trips the latch.

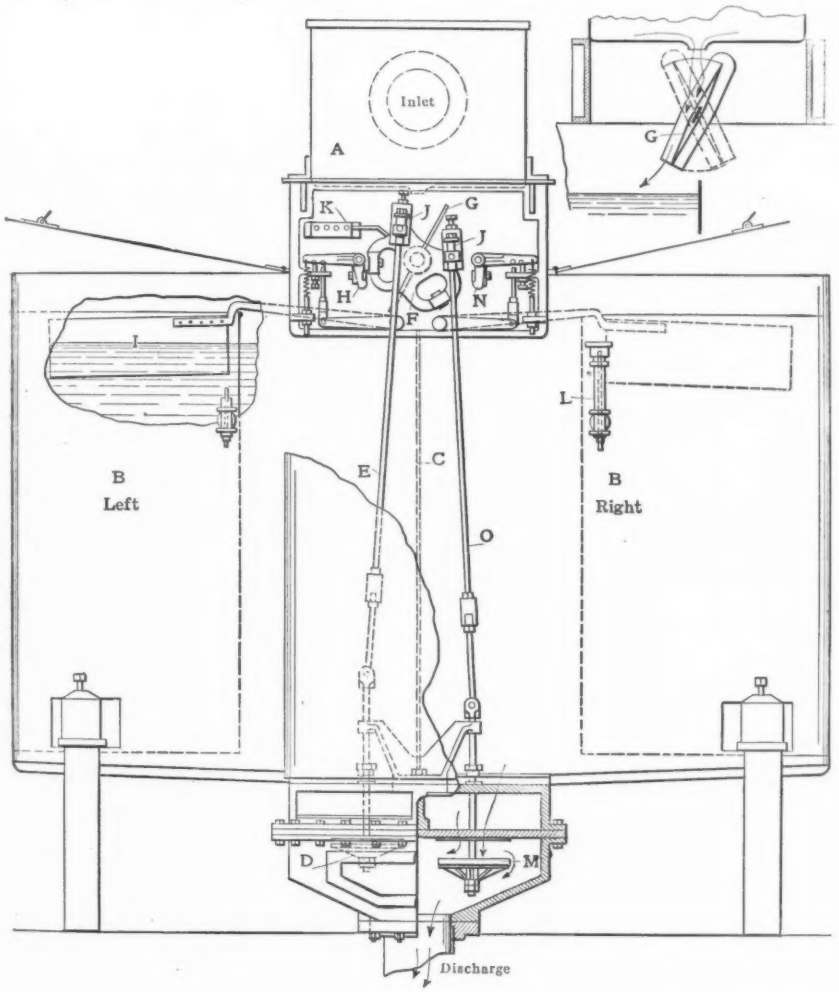


FIG. 2. SHOWING MECHANISM OF FILTER

This meter is manufactured by the Hammond Meter Company, 1318 to 1322 Chemical building, St. Louis, Mo.

The Liberty "Type B" Feed Water Regulator

We herewith illustrate a type of feedwater regulator, in which the water column is attached to the boiler in the usual manner. Within the column is a float with a stem extending through the guide plate, and engaging with a lever which actuates a valve, by means of buttons so placed that they actuate the lever in a positive manner with the rise and fall of the water level. This is illustrated in Fig. 1.

The lever is pivoted to a leg extending from the removable pilot-valve casing surrounding the chamber. On the right-hand end of the arm the valve stem is pivoted. The construction of the pilot valve is shown in the upper section of the illustration, also in Fig. 3. The controlling valve shown in Fig. 2 is placed at some convenient point in the feed line, so that the water flowing to the boiler passes through the valve opening.

The operation of the regulator is as follows: With the water in the boiler at the proper level, say the second gage, the valve on the end of the lower stem connecting with the lever operated by the float is opened and the valve on the end of the upper stem in the pilot-valve chamber is closed. Steam is, under this con-

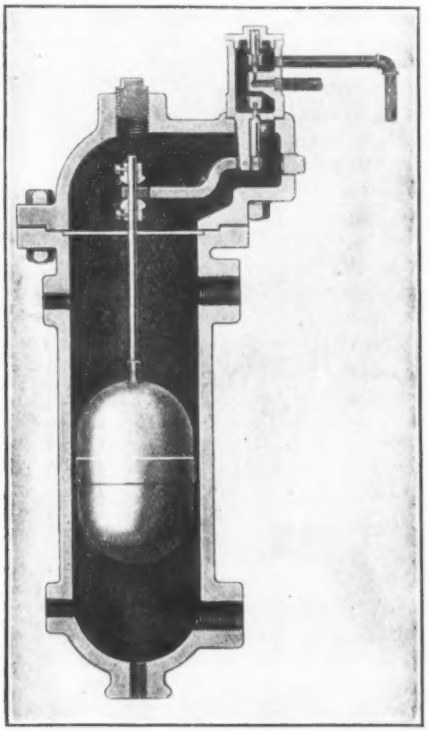


FIG. 1. LIBERTY "TYPE B" REGULATOR

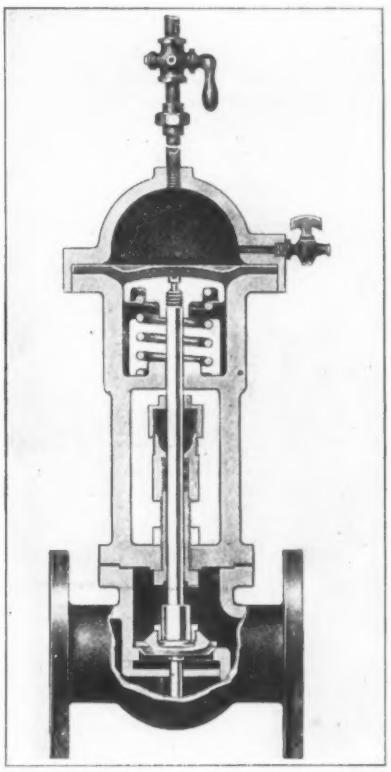


FIG. 2. THE CONTROLLING VALVE

dition, entering the upper pilot-valve chamber and passing through the upper pipe into the chamber on top of the controlling valve, the pressure forcing the controlling valve to its seat. As the water evaporates in the boiler the water level lowers and the weight of the float is gradually transferred to the lever connecting the valve and float, until the weight of the float overcomes the steam pressure holding the valve opposite the upper steam entrance on its seat. The valve then unseats and the weight of the float seats the admission valve and the steam that is contained in the upper pipe passes through the exhaust valve and out through the bottom pipe to the atmosphere. This relieves the pressure on top of the diaphragm and permits the controlling valve to open and admit water to the boiler. This action continues until the water level has been raised about ½ inch, and as the water level rises in the boiler and column, the float has a tendency to rise also, but the steam pressure on the admission valve tends to keep that valve closed and consequently prevents the float from rising until the weight, due to the increased displacement of the float, overcomes the pressure at the admission valve. As it opens, the exhaust valve opposite the upper pipe connection closes, causing the steam to enter the controlling-valve pipe or upper pipe, thus forcing the controlling valve to its seat.

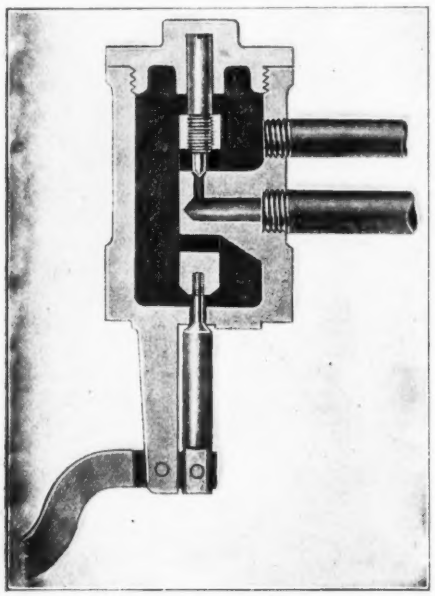


FIG. 3. PILOT VALVE

As the admission and exhaust valves are in one piece, they operate together and are positive in their operation. If adjustments are necessary, it is only necessary to remove the cap on top of the pilot-valve chamber and screw up or down on the exhaust-valve stem, as the case may require. This device is manufactured by the Liberty Manufacturing Company, 6910 Susquehanna street, Pittsburg, Penn.

The Volz Combined Surface Condenser and Feed-water Heater

Usual practice in heating feed water has been to use a primary heater, installed between the engine and condenser, a secondary heater utilizing the exhaust from auxiliaries, or perhaps both in the same plant. A departure from this practice is found in the Volz combined surface condenser and feed-water heater illustrated in the accompanying half-tones and recently placed on the market by the Wheeler Condenser and Engineering Company, Carteret, N. J.

The feed-water heater is incorporated in the upper part of the condenser shell, certain tubes being set aside for heating the feed water and communicating at either end with suitable inlet and outlet passages separate from the regular circulating water passages. These tubes are placed near where the exhaust steam enters, and therefore receive the benefit of the full temperature of the exhaust. They are of the same size as the condenser tubes, and, as will be noted, require very little additional space. In a condenser of this type the water-chamber tube-head division plates are composition, cast in one piece, and are made to withstand boiler pressure. Suitable cover plates provide access independently to both heater tubes and condenser tubes. The heater section can be cut out of service without interfering with the condenser section.

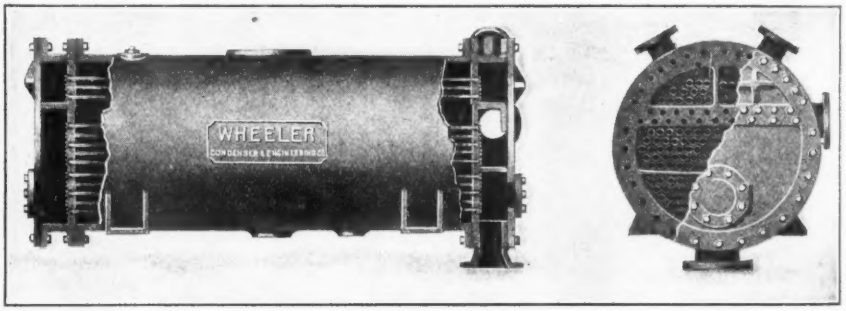


FIG. 2. CYLINDRICAL DESIGN OF VOLZ HEATER AND CONDENSER

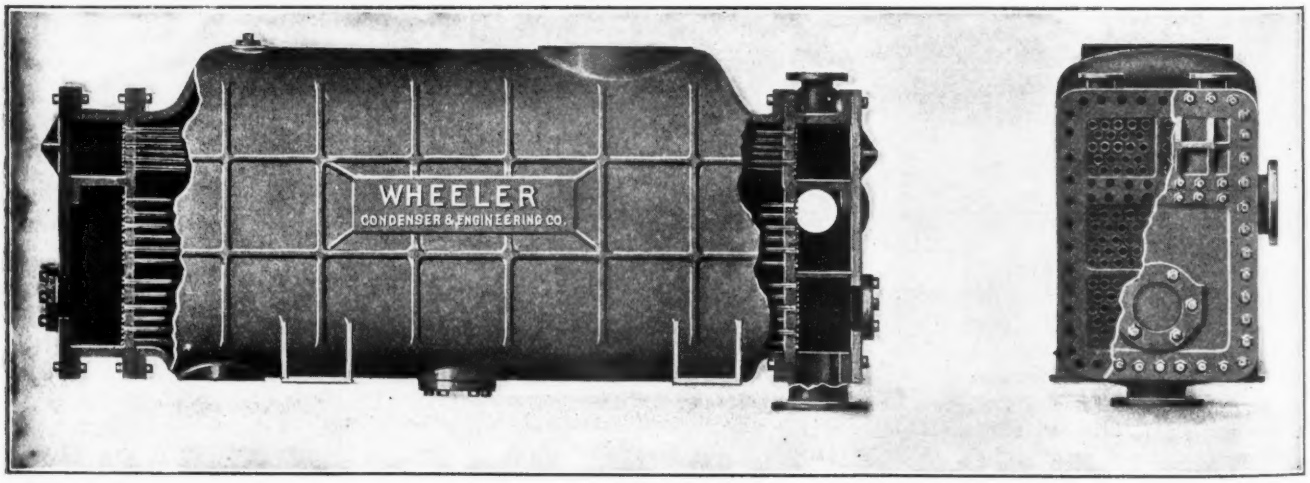


FIG. 1. RECTANGULAR DESIGN OF VOLZ COMBINED SURFACE CONDENSER AND HEATER

The H. W Johns-Manville Company, of New York City, has placed on the market the "Leak-No" metallic compound for repairing leaks and defects in iron and steel. It is chemically prepared, resembling powdered iron, and is mixed with water and applied like putty. The manufacturer claims that it metallizes and becomes a permanent part of the article to which it is applied.

A. S. M. E. Annual Meeting

The twenty-ninth annual meeting of the American Society of Mechanical Engineers will be held in the Engineering Societies building, 29 West Thirty-ninth street, New York, December 1 to 4, inclusive. The Gas Power Section will meet at the same time. The opening session will begin at 8:45 p.m. on Tuesday, December 1, when the president, M. L. Holman, will deliver an address on "The Conservative Idea as Applied to the American Society of Mechanical Engineers." The president's address will be followed by a social reunion, to which ladies are invited.

The following papers are expected to be presented at the meeting:

"The Engineer and the People." By Morris Llewellyn Cooke.

"Aëronautics." By Major George O. Squier, U. S. A.

"A Method of Obtaining Ratios of Specific Heat of Vapors." By A. R. Dodge.

"The Total Heat of Saturated Steam." By Dr. Harvey N. Davis.

"Fuel Economy Tests." By C. R. Weymouth.

"An Automatic System for Firing Fuel Oil." By C. R. Weymouth.

"Efficiency Tests of Milling Machines and Milling Cutters." By A. L. DeLeeuw.

"Metal Cutting Tools Without Clearance." By James Hartness.

"Interchangeable Involute Gear Tooth Systems." By Ralph E. Flanders.

"Durability of Gears in Electric Railway Service." By Norman Litchfield.

"Industrial Photography." By S. Ashton Hand.

"Articulated Compound Locomotives." By C. J. Mellin.

"Liquid Tachometers." By Amasa Trobridge.

"Training Workmen." By H. L. Gantt.

"An Averaging Instrument for Polar Diagrams." By Prof. W. F. Durand.

"Salt Manufacture." By George B. Willcox.

"Reminiscences of a Gas Engine Designer." By L. H. Nash.

"Possibilities of the Gasolene Turbine." By Prof. F. C. Wagner.

"Physical Properties of Carbonic Acid and the Conditions of its Economic Storage for Transportation." By Prof. R. T. Stewart.

"The Slipping Point of Rolled Boiler Tube Joints." By O. P. Hood and Prof. G. L. Christensen.

"Tests on Friction Clutches for Power Transmission." By Prof. Richard G. Dukes.

On Wednesday evening, Lieut. Frank P. Lahm, of the United States Signal Service, will lecture on the Wright Brothers' aëroplane. On Thursday evening the annual reception will be held.

American Peat Society Convention

The Toledo meeting of the American Peat Society, on October 22, 23 and 24, was a decided success. In the absence of the president, Dr. J. H. Pratt, who sent some encouraging words, Prof. Charles A. Davis, of Ann Arbor, Mich., called the meeting to order on Thursday, October 22, at 10:30 a.m. After a few preliminary remarks he introduced Mayor Brand Whitlock, of Toledo, who welcomed the delegates.

Otis E. Moulton, of New Hampshire, reported for New England. He gave a vivid description of the various attempts made in Maine, New Hampshire and Massachusetts, and is convinced that quite a peat industry will spring up there during the next season.

Carl Kleinstueck, of Kalamazoo, Mich., reported for the northwestern States. He had received numerous inquiries, and visited Mason City, Iowa, where he was called upon to pass judgment upon some excellent peat bogs found there. The outcome was the establishment of a plant at Fertile, Iowa, successfully operating all summer. His own plant was working at its full capacity, and he could have sold three times as much as he produced at $5 per ton.

Erik Nystrom, of the Canadian Bureau of Mines, gave a brief report, stating that he knew of only two places where they are actually making peat fuel in Canada. Many companies have been formed, but nothing further has been heard from them. The government has been interested in the matter of peat development, and some surveys of different peat bogs have been made by the Bureau of Mines, which will establish a peat-gas and power plant for experimental purposes during the coming year.

J. McWilliam, vice-president for Canada, reported on the work done in the Canadian district, emphasizing the development of a process for making peat briquets, and his experiments in using peat dust for fuel under the boiler, which he had successfully accomplished with peat dried to 5 per cent. of moisture.

F. J. Bulask, of Toledo, spoke on the work in the vicinity of Toledo. His peat-fuel plant has been hampered in its development because of lack of transportation facilities, but the delay has given time for experimental work in various directions. He emphasized the great need for a practical dryer for artificially drying peat fuel.

The secretary, Julius Bordollo, then read the minutes of the last meeting, made the financial report, and reviewed the accomplishments of the work done in the past year. A committee was appointed, consisting of Mr. Bulask, of Ohio, and Mr. Keller, of Indiana, to formulate plans for securing an experimental peat plant under Federal control. Mr. Phillip, of New Jersey, was appointed chairman of a committee to secure cheaper freight rates on peat and peat products. Two new sections, one for New York, and one for New England, each with a vice-president, were added.

The board of directors reported the re-election of Professor Davis as editor-in-chief, and presented for election his name as an honorary member; also, that one of the directing officials of each of the various European peat societies be elected honorary member. The recommendations were adopted.

Three cities, Detroit, Boston and New York, were presented for the next meeting. A vote was cast and resulted in the choice of Boston. It will be held in September, 1909. It is proposed to arrange a peat exhibition in which will be shown the various uses of peat, together with drawings and illustrations of plants and peat machinery.

The papers read at the meeting were as follows: "Commercial Aspect of Gasifying Peat," by Robert Schorr, engineer, San Francisco; "Utilization of Peat," by Dr. Samuel S. Jodidi, Agricultural Experiment Station, East Lansing, Mich.; "Peat and Swamp Land," by Joseph Hyde Pratt, president American Peat Society; "Life in a Michigan Peat Marsh," by Carl Kleinstueck, Kalamazoo, Mich.; "Peat in Ireland," by Herbert Garnett, Eaton Rapids, Mich.; "Briquetting of Peat," by Otis E. Moulton, Dover, N. H.; "Latest Developments in Peat Gas Producers," by Dr. Otto Zwingenberger, New York; "Peat in Indiana," by A. E. Taylor, Findlay, Ohio.; "Artificial Wood made from Peat," by F. Schuenemann, St. Louis, Mo.; "Latest Peat Researches of the United States Geological Survey," by Prof. Charles A. Davis, Ann Arbor, Mich.

The election of officers resulted as follows:

President, Joseph Hyde Pratt, State geologist, North Carolina, Chapel Hill, N. C.

Vice-presidents: For the Eastern States — Marion R. Campbell, United States Geological Survey, Washington, D. C. Great Lakes and Mississippi Valley—Carl Kleinstueck, Kalamazoo, Mich. Southern States—Robert Ranson, Crescent City, Fla. Pacific States—Prof. J. G. Schugham, University of Nevada, Reno, Nev. Canadian—Dr. J. McWilliam, London, Ont. New York Section—Prof. F. R. Stevens, Skaneateles, N. Y. New England Section — E. C. McKenney, Devonshire building, Boston, Mass.

Secretary-treasurer, Julius Bordollo, Kingsbridge, New York City.

Skill in handling the reverse lever and throttle gets as many heavy trains in on time as big locomotives carrying a high steam pressure. Skill with the injector counts for as much as skill with the scoop if the steam gage is any guide.—C. B. Conger.

Brooklyn's Associations Have a Good Time

The first annual entertainment and reception of the combined associations of engineers of the borough of Brooklyn, N. Y., was held at Prospect hall, Friday evening, November 13. The combination comprises the Modern Science Club, Brooklyn Council No. 8 and Melville Council No. 9 of the Universal Craftsmen, Nos. 8, 27, 41 and 57 of the National Association of Stationary Engineers, and the Associated Board of Engineers. The event proved to be the largest social gathering of engineers ever held in Brooklyn, fully two thousand members and friends being present, including many prominent persons in engineering circles. The nearby cities were well represented. A high-class vaudeville performance was followed by dancing. The several committees deserved the congratulations bestowed upon them for their conscientious work in making the occasion so great a success. The officers are as follows: James O. Westberg, president; William Smith, vice-president; Charles H. McCuen, recording secretary; Frank Martin, financial secretary; George O. Kaley, treasurer. The next social occasion of the combined engineers will be a steamboat excursion in June, 1909, the arrangements for which are now being made.

Marine Engineer's Dinner

The third annual dinner of the Marine Engineers of the Municipal Ferries of the City of New York took place Wednesday evening, November 11, at Moquin's downtown restaurant, there being seventy-five members and guests present, including William Yates, national president of the Marine Engineers' Benevolent Association. L. F. Oliver was toastmaster and introduced the following speakers: William Yates, George King, John Berry, Lawrence Hanlon, W. H. Powers, Frank Steele, Jesse Ackerbauer, William Du Bois, James Waters, John Safford and C. A. Hawkins. An enjoyable entertainment was furnished by Henry Elder, J. Lloyd Wilson, William Murray, Herbert Self, Frank Corbett and Jack Armour. J. Katsenstein was at the piano. The success of the occasion is due to the efforts of the following committee of arrangements: L. F. Oliver, John Howard, Joseph Mason, Emmit Charlton, John O'Neill.

Seth Boyden Association No. 7, National Association of Stationary Engineers, will hold an entertainment and smoker at its hall, 108 Market street, Newark, N. J., on Wednesday evening, November 25. The committee of arrangements is making great preparations, and a good time is assured.

Personal

Walter B. Snow, publicity engineer, of Boston, Mass., has been appointed by Governor Guild a member of the Massachusetts Commission for the Blind.

Orman B. Humphrey, consulting engineer, Bangor, Me., who, for the past year has been engaged on the preliminary engineering in connection with the Ryegate Light and Power Company, hydroelectric development on Wells river, Vermont, has completed his work, and active construction has begun.

Ellgood C. Lufkin has resigned as vice-president and general manager of the Snow Steam Pump Works and the Holly Manufacturing Company, subsidiaries of the International Pump Company, to become associated with a large oil company in Texas. The resignation will take effect on January 1.

Obituary

G. M. Davis, president of the G. M. Davis Regulator Company, of Chicago, died at Morrill, Tex., Saturday, November 14. Mr. Davis had long made a study of means for controlling steam pressures and is credited with manufacturing the first reducing valve made in this country. In 1875 he founded the firm of G. M. Davis & Co., originally for the purpose of manufacturing air valves for steam radiators; gradually the scope of the business grew until it embraced a complete line of pressure-regulating devices, besides many other steam specialties, and in 1899 was incorporated under the name of the G. M. Davis Regulator Company. Of late years, Mr. Davis, who was sixty-three years of age, had not taken an active part in business, but was in his usual good health on departing for Texas to look after a business project in which he was interested. On November 7 he suffered a stroke of paralysis, from the effects of which he died a week later. Mr. Davis leaves a widow and two sons, George C. and W. E. Davis, to mourn his death.

The annual entertainment and reception of the Municipal and Civil Service I. U. S. E., No. 319, of Brooklyn, was held at the labor lyceum, Monday evening, November 16. This was the first social event of this growing association. Fully twelve hundred engineers and friends were in attendance. An enjoyable vaudeville show was followed by dancing. The officers are as follows: Thomas Roche, past president; John M. Cunliffe, president; Thomas Robb, vice-president; George Williams, treasurer; Joseph Donnelly, financial secretary; Charles Hanlon, recording secretary; Robert Hancock, guard; Edward A. Morwin, Jr., conductor.

Business Items

The Avery Scale Company, of Milwaukee, Wis., has opened an office at 2 Rector street, New York, with C. J. Simeon as Eastern manager.

Recent orders taken by the Ohio Blower Company, Cleveland, Ohio, include 32 Swartwout cast-iron exhaust heads, in sizes from 2½ to 14 inches, and 14 Swartwout separators.

Catalogs relating to mining machinery and equipment, complete, power plants, coke ovens and machine tools are requested by the engineering department of the By-Products Fuel Company, Moundsville, W. Va.

Burdett Loomis, Jr., has opened a sales office in the Connecticut Mutual building, Hartford, Conn., where he will look after the interests of the Power and Mining Machinery Company, builder of the Loomis-Pettibone gas producers, and also the Snow Steam Pump Works, of Buffalo, N. Y., builder of the Snow horizontal double-acting gas engines in all sizes.

We have received from the Harrison Safety Boiler Works, Seventeenth and Clearfield streets, Philadelphia, Penn., a 20-page booklet, entitled "Separator Talks," treating of the first principles of separating water or oil from steam or gas. In addition, the booklet contains drawings and tables of dimensions of the "Cochrane" steam and oil separators manufactured by this company.

The Buckeye Boiler Skimmer Company, South End, Toledo, Ohio, received a letter from A. Gilmore's Sons, proprietors of the Toledo dry dock, in which they say: "The skimmer you put in our boiler has been giving the very best of results, and has fulfilled all the promises you made for it. We are thinking of increasing our boiler capacity, and in that event will want another skimmer put in.

One of the most important orders recently booked in the electrical field is that for about 2500 horsepower of induction motors for the Clark Thread Company, Newark, N. J. The order itself is of considerable size, but its chief importance is its being the beginning of the electrification of these mills, probably the most extensive cotton mill in the United States. The mill has been driven by several steam engines, and this purchase of induction motors is the first step in electric drive. The order was awarded to the Crocker-Wheeler Company, of Ampere, N. J. The motors are 5500-volt, 60-cycle, 3-phase machines and the present order aggregates about 2500 horsepower, the motors ranging from 25 to 150 horsepower each.

New Equipment

The city of Boone, N. C., contemplates constructing a water-works system.

The Slidell (La.) Light and Ice Company will install an electric-light equipment.

Bear State Lumber Company, Womble, Ark., will, it is said, install an electric-light plant.

City of Sebree, Ky., will vote on issuance of $13,500 bonds for water-works system.

The Tropical Ice and Cold Storage Company, Tampa, Fla., will rebuild plant recently burned.

It is reported that the Kloss Ice Cream Company, Wheeling, W. Va., will install an ice plant.

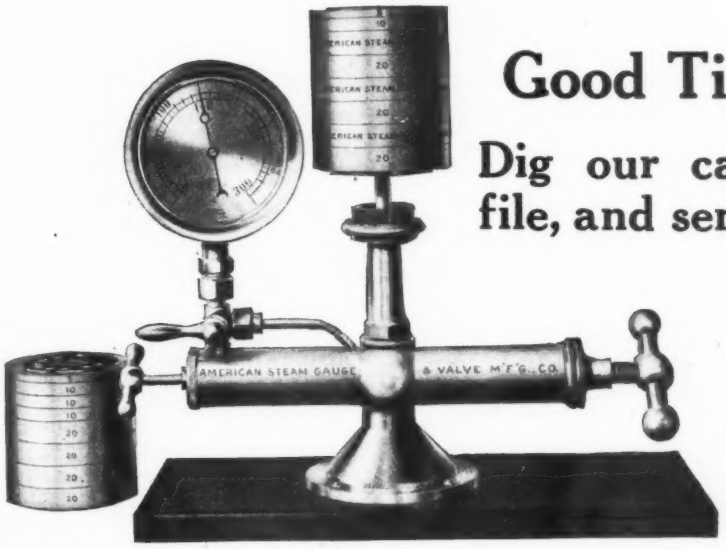
The electric-light plant at the State School for the Blind at Fort Gibson, Okla., was destroyed by fire.

The N. R. Springer Company, Bethel, Me., it is said, contemplates installing an electric-light plant.

The city of Lindsay, Okla., will vote on issuance of $40,000 bonds for electric-light and water-works system.

American Specialties

Represent the Best in the Line as They Always Have



Good Times Are Here

Dig our catalog out of your file, and send us your inquiries

If it's branded "AMERICAN" it's the best you can buy.

The American Dead Weight Gauge Tester

keeps your steam gauges in the "straight and narnow path." It is the simplest and most accurate tester there is, possessing all the advantages of the Mercury Column, in a much smaller space. By its use the waste which results from inaccuracy can be entirely eliminated and gauges can be relied upon.

SEND FOR DESCRIPTIVE MATTER

American Steam Gauge & Valve Mfg. Co.

208-220 Camden Street, Boston, Mass.

New York, 26 Cortlandt St. Atlanta, 835 Equitable Bldg. Chicago, 7-9 S. Jefferson St.

Pittsburg, Frick Building Annex
Montreal, 444 St. James Street
San Francisco, 247 Pine Street
Los Angeles, 213 S. Los Angeles Street

The Cleveland (Ohio) Electric Illuminating Company has purchased site on which a new power house will be erected.

The Village Board, Walthill, Neb., is considering the question of establishing an electric-light and water-works system.

The electric-light and water-works plant owned by the La Porte City (Iowa) Public Utilities Company was burned.

Arrangements are being made by the Faatz-Reynolds Felting Company, Lestershire, N. Y., to operate its plant by electricity.

Work has been begun on the new plant of the People's Ice and Cold Storage Company, Omaha, Neb., which is to cost $100,000.

The citizens of East Point, Ga., have voted in favor of issuing $85,000 bonds for electric lighting, sewerage and water-works system.

The citizens of Hillyard, Wash., voted to issue $35,000 bonds for the construction of water works. R. E. Brown, Hillyard, engineer.

The Town Council, Mifflinburg, Penn., has under consideration the installation of an auxiliary steam plant in the municipal electric-light plant.

C. E. F. Ahlm, Caxton building, Cleveland, Ohio, will prepare plans and specifications for proposed municipal electric-light plant at Lima, Ohio. Estimated cost, $70,000.

The Stoyestown (Penn.) Light, Heat and Power Company has been formed to furnish electric light and power. D. E. Long, J. E. Morgret and others, organizers.

The city of Augusta, Ga., will open bids November 24 for a pumping engine of 6,000,000 daily capacity and a 450-horsepower steam plant. Nisbet Wingfield, city engineer.

Bids will be received until November 30 at the office of Superintendent of Prisons and Prisoners, Department of Justice, Washington, D. C., for one 25-horsepower motor for the U. S. Penitentiary, Atlanta, Ga.

New Catalogs

British American Chemical Company, Norwood building, Paterson, N. J. Folder. Brisam boiler compound.

Pratt & Whitney Co., Hartford, Conn. Catalog. Multiple drills. Illustrated, 28 pages, 9x12 inches.

The Mechanical Rubber Company, Cleveland, Ohio. Catalog. Marco packings. Illustrated 60 pages, 5x8 inches.

The Wickes Boiler Company, Saginaw, Mich. Catalog. Wickes horizontal tubular steam boiler. Illustrated, 32 pages, 6½x10 inches.

Wheeler Condenser and Engineering Company, Carteret, N. J. Bulletin No. 102. Surface condensers. Illustrated, 24 pages, 8x10½ inches.

American Radiator Company (Bundy Department), 104-108 West 42d street, New York. Catalog. Bundy steam traps. Illustrated, 64 pages, 6x9 inches.

The Gearless Gas Engine Company, 19 West Washington street, Springfield, Ohio. Catalog. Gearless gas and gasolene engines. Illustrated, 16 pages, 6x9 inches.

The Milwaukee Metal Working Company, Milwaukee, Wis. Booklet. Werder graphite and oil pump for cylinder lubrication. Illustrated, 8 pages, 3½x6 inches.

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 280 Dearborn St., Chicago.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

WANTED—A first class chief electrician to take charge of all electrical equipment at a large mining and furnace plant in the South. Equipment consists of d.c. generators, motors, lights, cranes, locomotives and telephones. Must have a thorough, practical knowledge of motor and trolley work, including armature and field winding, and be able to do electrical repair work of any kind. Applicants state age and full qualifications. Box 57, POWER.

WANTED—By prominent engineering house on the North Pacific coast, a practical mechanical draftsman. One acquainted with power plant design preferred. Splendid opening for one who is in earnest. Address, giving full particulars as to qualifications, salary wanted, etc. Box 65, POWER.

AGENTS to sell one of the best known and widely advertised shaking grates on the market. Exclusive territory granted to anyone who can make good. Liberal commission. Perfection Grate Co., Box 1081, Springfield, Mass.

WANTED—Young man familiar with the erection and testing of high speed automatic engines. One who has had some outside erecting experience preferred. To receive consideration give full details of experience, employers' names, duration and compensation last two engagements. Box 63, POWER.

WANTED—An engineer to take charge of large steam plant in Massachusetts. Salary $125.00. No one considered who is not now holding good job. Applicants who do not state age, previous experience in detail, and give references to former employers, will not be considered. A good job for a good man and a chance to grow. Address Box 62, POWER.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Position by an energetic young man (25), with good practical and theoretical knowledge of internal combustion engines; can prove his ability. Exacting reference as to habits, reliability, etc. The West preferred. Box 66, POWER.

CHIEF ENGINEER having 20 years' experience with modern engines, boilers and a.c. and d.c. generators, desires position. Can give references and good economy. Box 61, POWER.

Miscellaneous

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-examiner, U. S. Patent Office, McGill Bldg., Washington, D. C.

A NEW STEAM TURBINE. Wm. L. Pope, 400 Pennsylvania avenue, Rochester, N. Y., inventor, wants to meet a party to talk over matters and place turbine on American markets. Patent No. 782267.

AN ESTABLISHED MANUFACTURER, owning a large foundry and machine shop with modern equipment and 15-ton crane, desires to get some young blood and a good line of heavy iron machinery, engines or tools to manufacture Address, with particulars as to line offered, Box 64, POWER.

PATENT AGENT in Japan. Patent, trademark, design, copyright. Most reliable, experienced engineer. Y. Tsurmy, 144 Bentencho, Ushigome, Tokio.

For Sale

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

ONE 23x60 SINGLE-CYLINDER, double-acting Harris Corliss. Pendulum ball governor with sectional cast-iron flywheel, 18 feet by 38 inches; good order, requirements changed, electric power being used. Almond Mfg. Co., Ashburnham, Mass.

150 HORSE-POWER tandem compound Corliss engine, in good order; 16-ft. wheel; 24-in. face. F. W. Iredell, 11 Broadway, New York.

BUSINESS OPPORTUNITIES—For sale, a free and clear, modern, going, paying plant, near Philadelphia, Pa., manufacturing staple steam specialties. First or second largest concern in its line. Appraised value, real estate, building and machinery, $93,000.00. Accounts receivable, $23,000.00. Inventory at cost, $53,000 00. Orders and contracts on hand sufficient to take product for next twelve months. The above offers an unusual opening for securing a manufacturing business with an established and valuable good will. "Banker," POWER.

FOR SALE—One 12 and 18x9x18 Buffalo regular fitted, outside end, packed plunger, pot valve pump. Stretcher rod type. Capacity, 500 gallons per minute. In first class condition. Address, The New York Edison Company, 55 Duane Street, New York.

FOR SALE—20"x42" improved Greene engine. Wheel 32"x14'. Used seven years. Also, 24"x48" improved Greene engine. Wheel 42"x16'. Used eight years. Both engines in first class shape. Can be seen running. The Capewell Horse Nail Co., Hartford, Conn.

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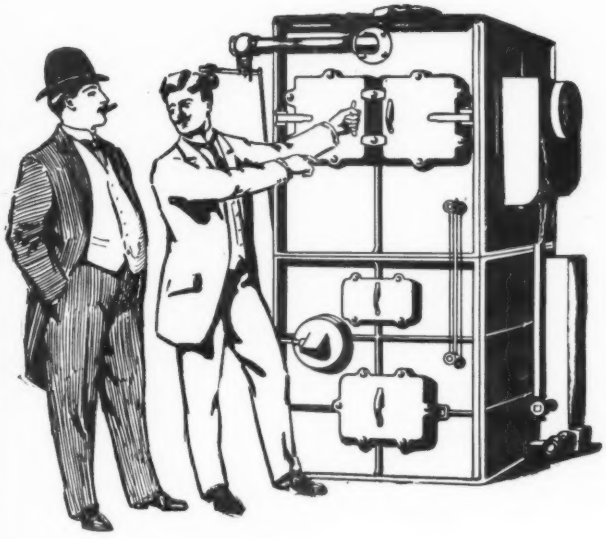

"EASY TO CLEAN"

is one of the strongest recommendations of the COCHRANE OPEN FEED WATER HEATER. Not only does it refer to the fact that the scale-forming matter can be shoveled out of the sedimentation chamber or scraped off the trays with much less labor than scale can be removed from the boiler, but it also implies that the Cochrane Heater *needs* cleaning occasionally, that is, it serves to arrest a large amount of impurities that otherwise would reach the boiler.

Pressure heaters, which are virtually closed continuations of the boiler feed pipe, on the other hand, do not have any noticeable purifying action. They make no provision for the escape of carbonic acid gas, which is necessary for the precipitation of carbonates, and further, the water is kept in rapid circulation (the more rapid the better for the heat transmission), and as such heaters are not provided with filters, there is little chance of their stopping any sediment. In fact, as far as closed heaters do stop sediment, it is a disadvantage, since it is almost impossible to clean a closed heater, and when closed heaters become clogged up with scale on one side of the heating surface and with oil and grease on the other, they become practically worthless.

The full temperature of 210° F., to which the water is raised in the Cochrane Heater, is not only valuable in saving coal, but brings about the precipitation of carbonates and the escape of corrosive air and gases. If your boiler feed water contains permanent hardness, that is, sulphates, chlorides or acids, our "Hot Process System" of Water Purification is recommended. This System takes advantage of the fact that the water should be heated in any case, and that heating will do all or more than lime will do in throwing down the carbonates. The "Hot Process System" combines, in fact, all the valuable qualities of the Cochrane Open Feed Water Heater with those of a perfect softening system, and it costs less, occupies less room and requires less skill and labor to care for and operate, than would the independent heater and softener.

We would be pleased to advise you about your feed water and heating and softening problems, and to send you our descriptive treatises upon request.

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Harrison Safety Boiler Works,

17th and Clearfield Sts., Philadelphia, Pa.

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Reliance Gauge Column Co., Cleveland, O.

Alcohol Distillery Apparatus

Continental Natural Gas Alcohol Co., Wheeling, W. Va.

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Stewart Heater Co., Buffalo, N. Y.

Cleaners, Turbine Boiler Tube

Lagonda Mfg. Co., Springfield, Ohio.

Clocks

American Steam Gauge and Valve Mfg. Co., Boston, Mass.

Every Boiler Needs

Clean Water

Pure Water

Hot Water

WEBSTER FEED WATER HEATER, PURIFIER AND FILTER

"I HAVEN'T seen the patient and don't know what's the matter with him, but give him this medicine every hour."

If a doctor gave you those instructions, would you follow them—and would a cure result if you did?

Just about the same principle applies to feed water heating and purifying—the prescription must follow a careful diagnosis.

The Webster
Feed Water Heater Purifier and Filter

is sold only after our expert engineers have thoroughly investigated the conditions surrounding a prospective buyer's plant. Then, when it is installed, we can positively guarantee that it will supply the boiler with perfectly pure water at the highest possible temperature. And to do this the "WEBSTER" uses only enough exhaust to get the desired heat. It is *not* a thoroughfare heater.

Over 2,250,000 h. p. are now in daily use—that's one indisputable evidence of WEBSTER satisfaction.

Booklet 12-F describes in detail.

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Camden, New Jersey

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Houghton & Co., E. F., Philadelphia, Pa

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Cling-Surface Co., Buffalo, N. Y.

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Southwark Foundry and Machine Co., Philadelphia, Pa.
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Wheeler Condenser & Engineering Co., New York.

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Fitchburg Steam Eng. Co., Fitchburg, Mass.
Minneapolis Steel & Mach'y Co., Minneapolis, Minn.
Shepherd Engineering Co., Williamsport, Pa.
Skinner Engine Co., Erie, Pa.
Southwark Foundry & Machine Co., Philadelphia, Pa.
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Skinner Engine Co., Erie, Pa.
Southwark Foundry & Mach. Co., Philadelphia, Pa.
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De La Vergne Machine Co., New York.
Du Bois Iron Works, Du Bois, Pa.

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Ball-Cooley Engineering Co., New York.

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Ball & Wood Co., Elizabethport, N. J.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

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Burt Mfg. Co., Akron, O.
Gardner Gov. & Separator Co., Quincy, Ill.
Hoppes Mfg. Co., Springfield, O.
Ohio Blower Co., Cleveland, O.
Patterson & Co., F. L., New York.
Pittsburgh Gage and Supply Co., Pittsburgh, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Whitlock Coil Pipe Co., Hartford, Conn.

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Crocker-Wheeler Co., Ampere, N. J.
Fort Wayne Electric Works, Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincinnati, O.
Westinghouse Elec. and Mfg. Co., Pittsburg, Pa.

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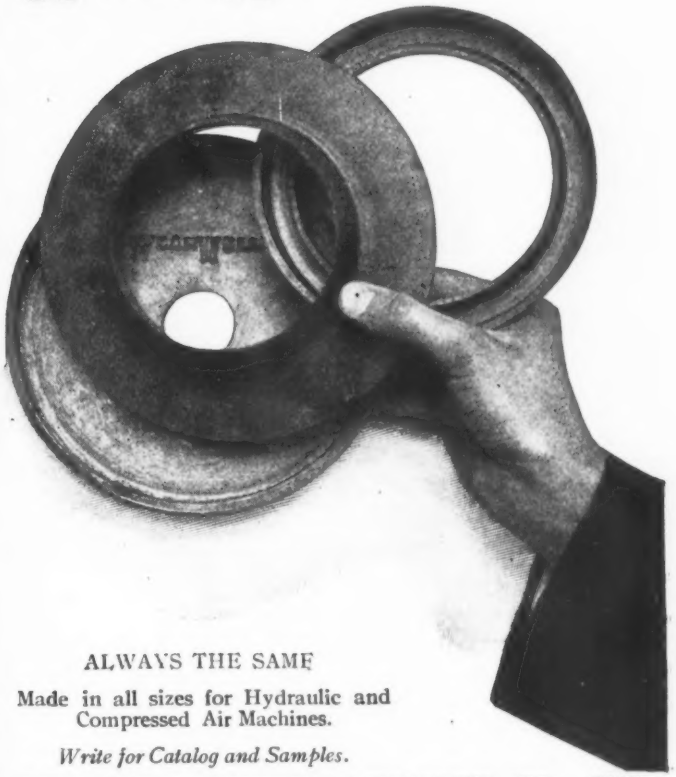

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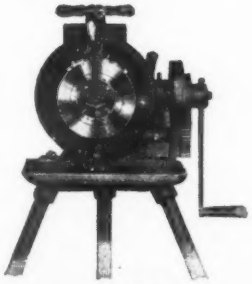

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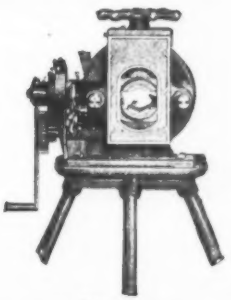

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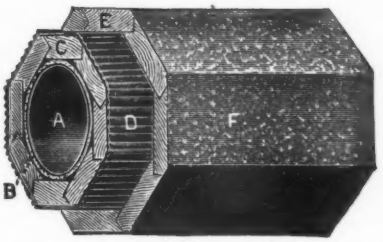

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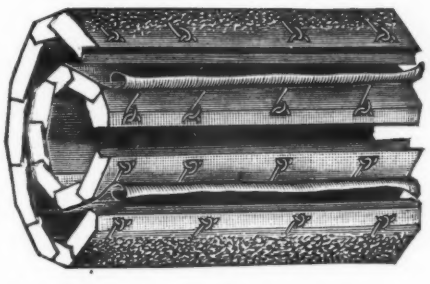

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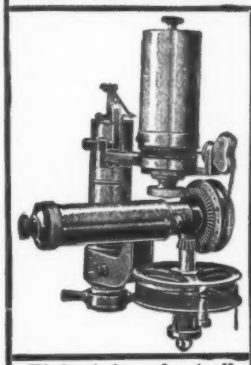

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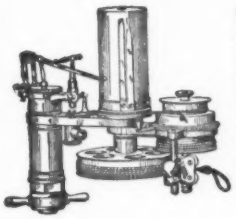

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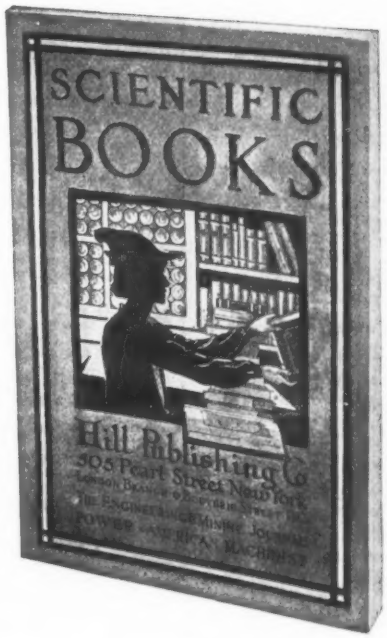

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Du Bois Iron Works, Du Bois, Pa.

Pumps, Force-feed Oil

Greene, Tweed & Co., New York.
Lunkenheimer Co., Cincinnati, O.

Pumps, Hydraulic

American Steam Pump Co., Battle Creek, Mich.
Warren Steam Pump Co., Warren, Mass.
Watson-Stillman Co., New York.

Pumps, Mining

American Steam Pump Co., Battle Creek, Mich.
Du Bois Iron Works, Du Bois, Pa.

Pumps, Oil

American Steam Pump Co., Battle Creek, Mich.
Deming Co., The, Salem, O.
Detroit Lubricator Co., Detroit, Mich.
Du Bois Iron Wks., Du Bois, Pa.
Lunkenheimer Co., Cincinnati, Ohio.
Penberthy Injector Co., Detroit, Mich.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Pumps, Power

Patterson & Co., F. L., New York.

Pumps, Pressure

Deané Steam Pump Co., Holyoke, Mass.

Pumps, Steam

American Steam Pump Co., Battle Creek, Mich.
Blake Mfg. Co., Geo. F., New York.
De Laval Steam Turbine Co., Trenton, N. J.
Du Bois Iron Works, Du Bois, Pa.
Epping-Carpenter Co., Pittsburg, Pa.
Gardner Gov. & Sep. Co., Quincy, Ill.
Lammert & Mann, Chicago, Ill.
McGowan Co., John H., Cincinnati, O.
Myers & Bro., F. E., Ashland, O.
Stewart Heater Co., Buffalo, N. Y.
Union Steam Pump Co., Battle Creek, Mich.
Wheeler Cond. & Eng. Co., New York.

Pumps, Triplex

Deming Co., The, Salem, O.

Pumps, Turbine

Alberger Condenser Co., New York.
Worthington, Henry R., New York.

Pumps, Vacuum

American Steam Pump Co., Battle Creek, Mich.
Warren Steam Pump Co., Warren, Mass.
Wheeler Condenser & Engineering Co., New York.

Punches, Hydraulic

Watson-Stillman Co., New York.

Purifiers, Steam

Hoppes Mfg. Co., Springfield, O.

Purifiers, Water

Buckeye Boiler Skimmer Co., Toledo, Ohio.
Eclipse Feed Water Heater and Purifier Co., Appleton, Wis.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Mfg. Co., Springfield, O.
Keystone Chemical Co., Phila., Pa.
Whitlock Coil Pipe Co., Hartford, Conn,

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Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Kitts Mfg. Co., Oswego, N. Y.
Lagonda Mfg. Co., Springfield, O.
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Watson & McDaniel Co., Phila., Pa.

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Berry Engineering Co., Chester, Pa.
Chaplin-Fulton Mfg. Co., Pittsburg, Pa.
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d'Este Co., Julian, Boston, Mass.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
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Davis Co., John, Chicago, Ill.
Davis Regulator Co., G. M., Chicago, Ill.
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Lagonda Mfg. Co., Springfield, Ohio.
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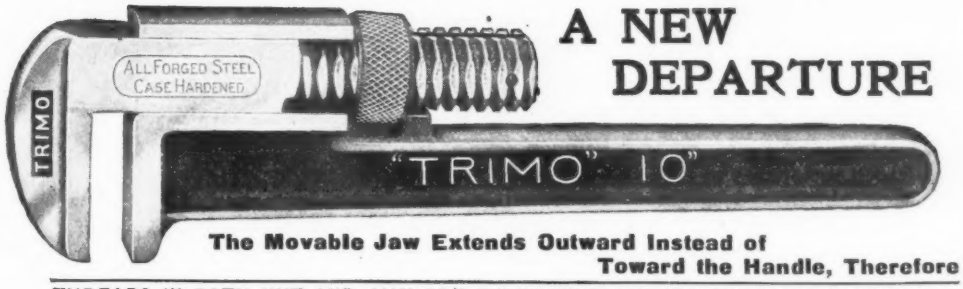

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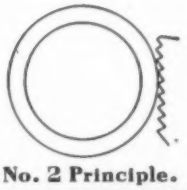

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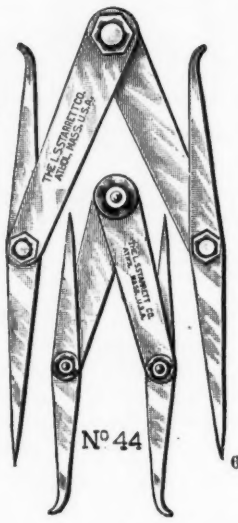

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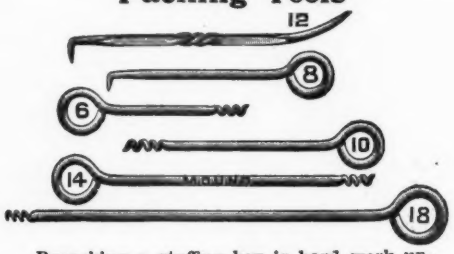

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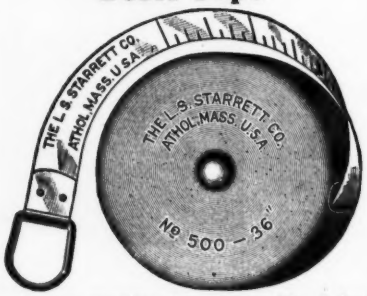

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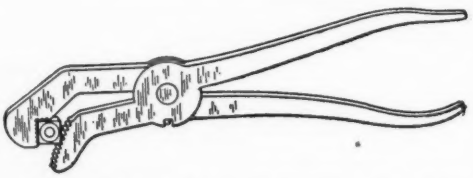

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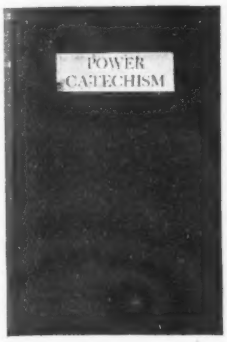

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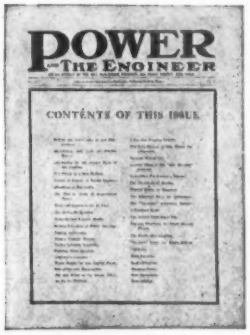

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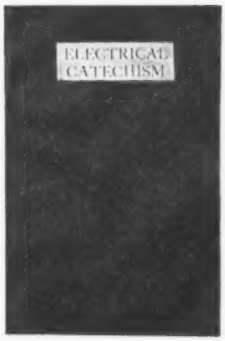

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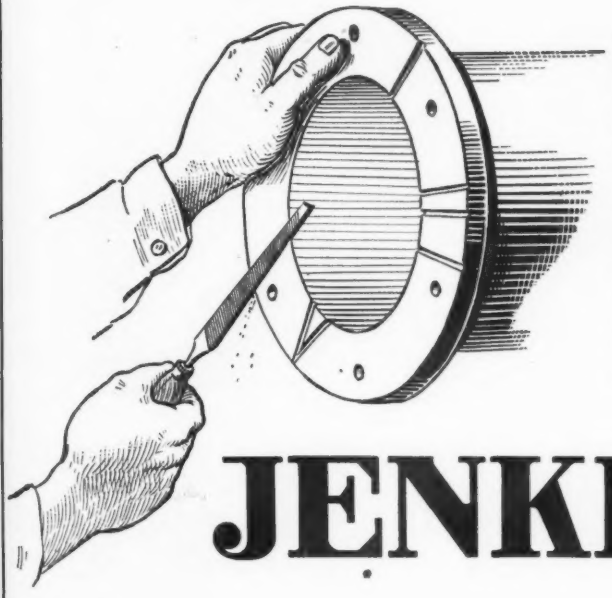

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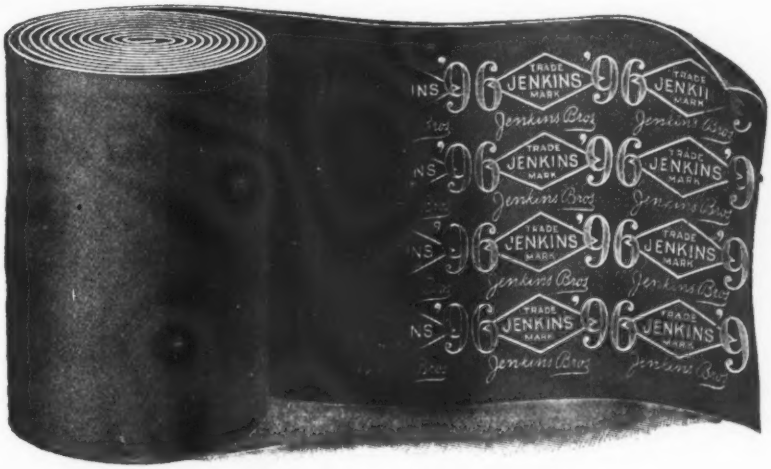

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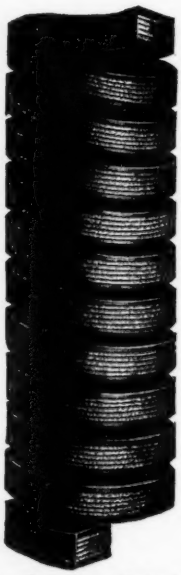

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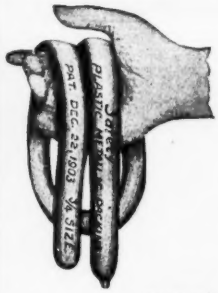

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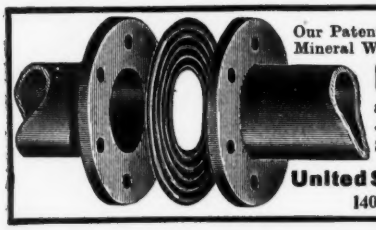

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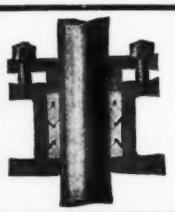

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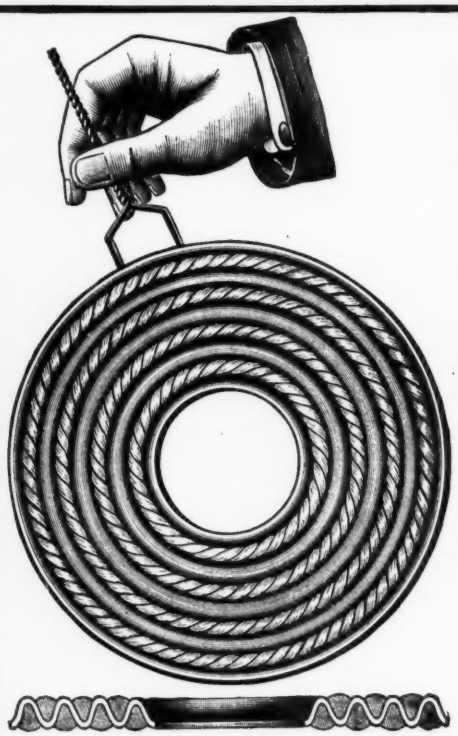

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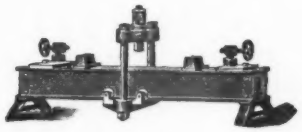

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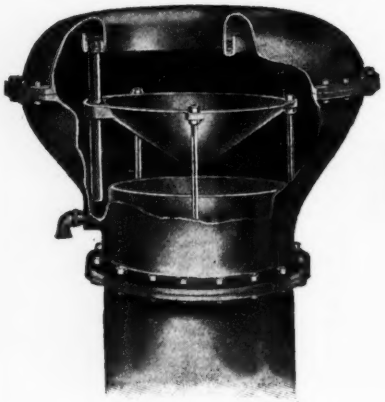

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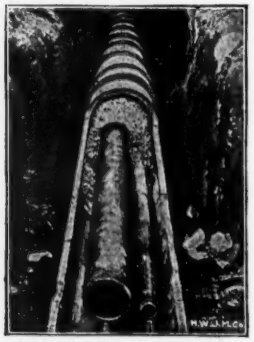

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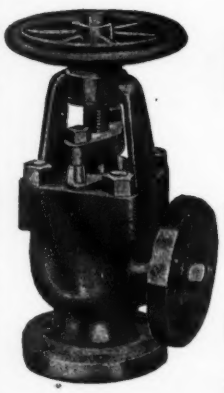


Manufacturers of the

EDWARD VALVE

For High Pressures, Superheated Steam and Water.

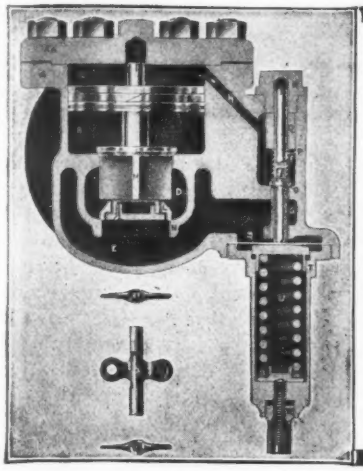
THE LAMMERT & MANN

Oil Dash Pots for Corliss Engines, Gas and Gasoline Engines.

LAMMERT & MANN,

ENGINEERS and MACHINISTS,

157 S. Jefferson St. CHICAGO, ILL.



OUT OF THE PATH OF INITIAL STEAM

IS THE CONTROLLING VALVE "O" OF THE

"COLLIN" STEAM PRESSURE REGULATING VALVE.

THIS IS ONLY ONE OF MANY EXCLUSIVE FEATURES POSSESSED ONLY BY THE "COLLIN" VALVE WHICH INSURES AGAINST TROUBLE FROM DIRT AND SCALE. YOU WILL BE INTERESTED IN A COMPLETE DECRIPTION AND THE OPINIONS OF ACTUAL USERS. WRITE TODAY.

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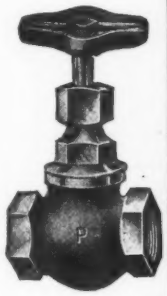
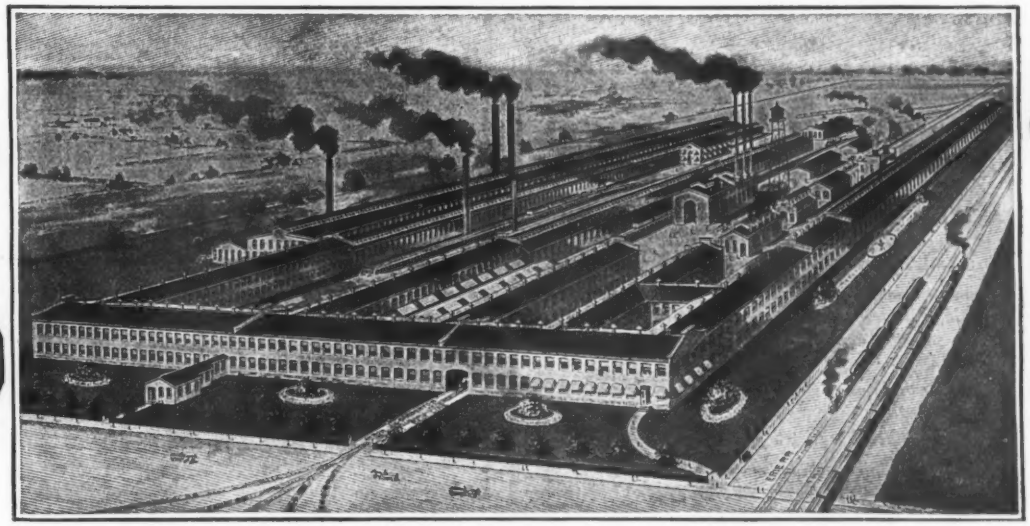
WE manufacture and carry in stock a complete line of standard and extra-heavy cast iron fittings both flanged and screwed; malleable iron fittings for steam and gas; recessed drainage fittings; iron body gate valves; iron body globe and angle valves; blow-off valves; pressure regulating valves; long radius fittings,





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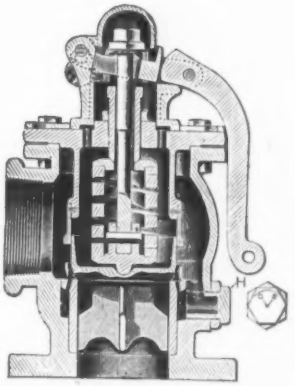
flanged and screwed; brass fittings from malleable and cast iron patterns; expansion joints; steam traps; pipe saddles; pipe hangers; brass valves; cocks, etc.

Pittsburgh Valve & Fittings Company. General Offices and Works, **Barberton, Ohio.**

Automatically Adjusts Itself To Wear

and consequently the Ashton Improved Lock-up Pop Safety Valve will require less of your attention and give you longer satisfactory service than any valve lacking this exclusive feature. *Write for catalog.*



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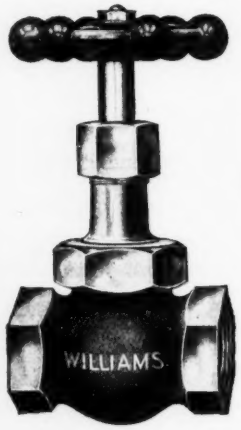
St. John's House, London, E. C.

Let The Williams Valve Prove Its Worth To You.



THE BEST WAY to determine the value of a Williams Valve is to *try it*. Try it in places where other valves won't stay tight—in other words give it the most severe test you can think of.

You will find the Williams valve particularly strong at any pressure up to 200 pounds and on account of its high-lifting disc and large seat opening, friction is reduced to minimum

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Try us out! Make us prove that the valves and pipage equipment we make have **very few equals** and **positively no superiors!** We are anxious that you do! We have been making good valves so long, and have been pleasing the most expert and most critical mechanics in such a large part of the civilized world for so long, that we are absolutely sure of our position!

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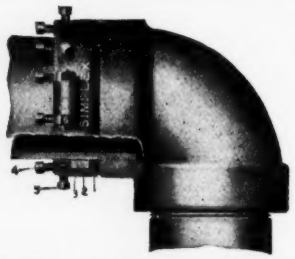

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can be made absolutely and permanently tight, provided you use the Simplex Pipe Clamp. Why allow your plant to bleed to death? WRITE!

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QUICKEST TIGHTEST MOST DURABLE **VALVES**

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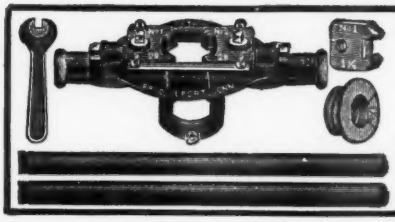

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PIPE CUTTERS,
VISES.

Manufactured by
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There are no inserted parts in the "KEWANEE" UNION.

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General Sales Offices,
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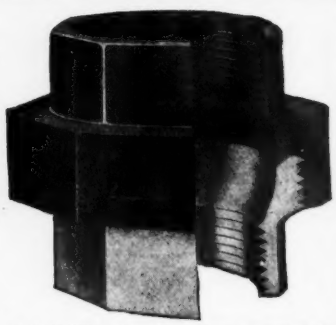

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Easy To Thread An 8" Pipe

"TOLEDO NO. 2"

if you use the Toledo Pipe Threading Devices.

They make the work as easy as the old method made it hard

Write today.

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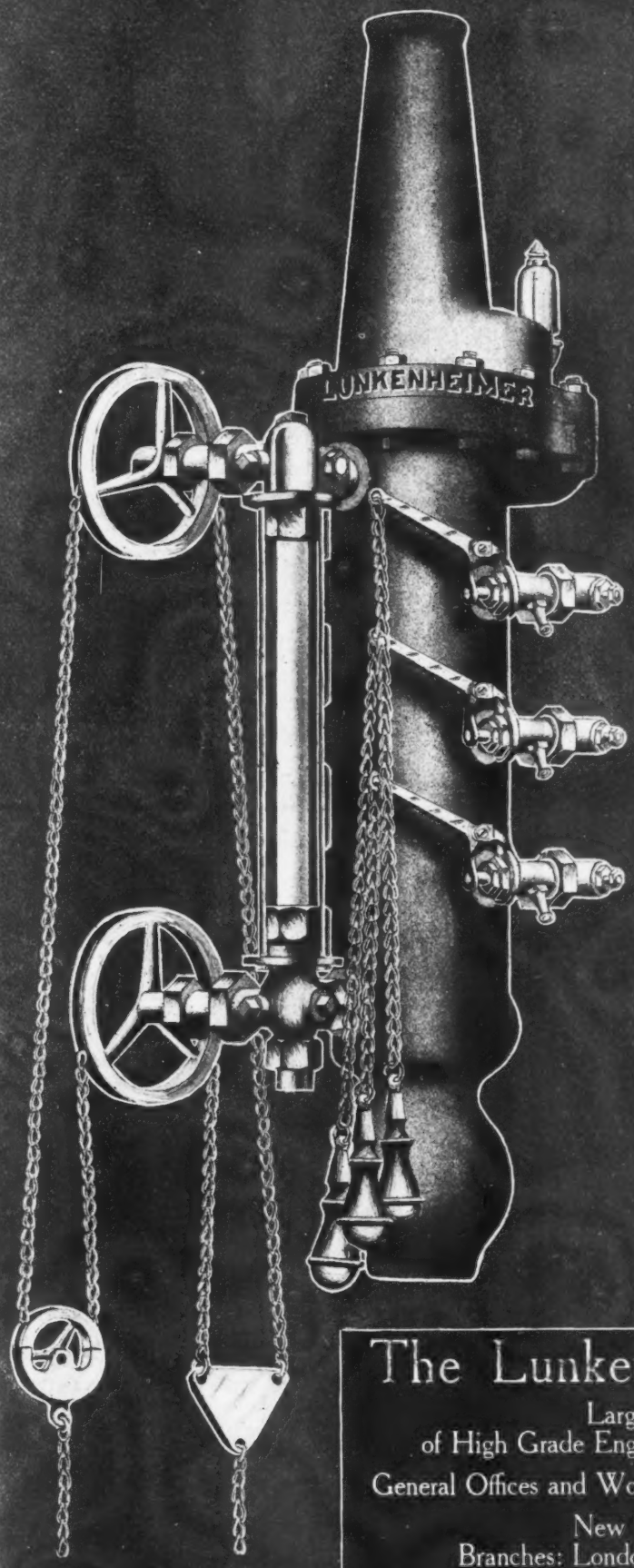

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It automatically sounds an alarm when the water in the boiler approaches the low or high danger limit, besides effecting a decided saving in fuel and boiler repair bills. Made in all sizes suitable for various types of boilers. Our catalog contains a complete description. Write for a copy.

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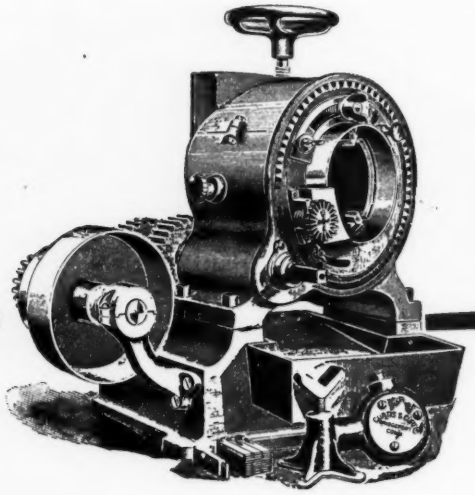

No Other Pipe Threading Machine

Has the shell adjustment for taking up the inevitable wear. This exclusive feature insures to the Forbes Patent Die Stock a longer period of accurate work, than can be had from any other machine.

The Forbes requires only enough space to handle the pipe and only one man to operate.

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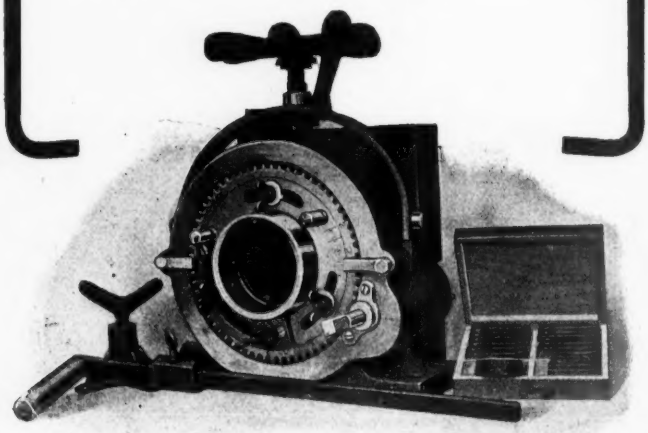

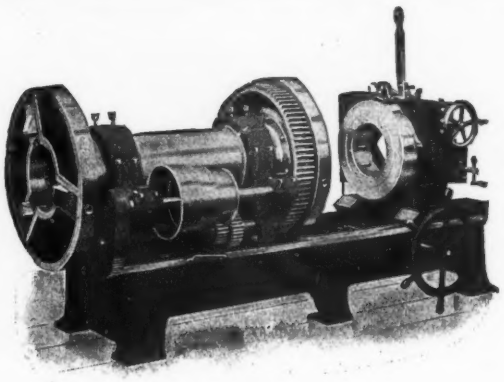

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"Foreman says that the machines cut the cleanest threads he has ever seen and while originally they have favored the installation of another make which they have been using for ten years, they now say they would not give the Bignall & Keeler for forty of the other make—the latter, too, is a very good machine."

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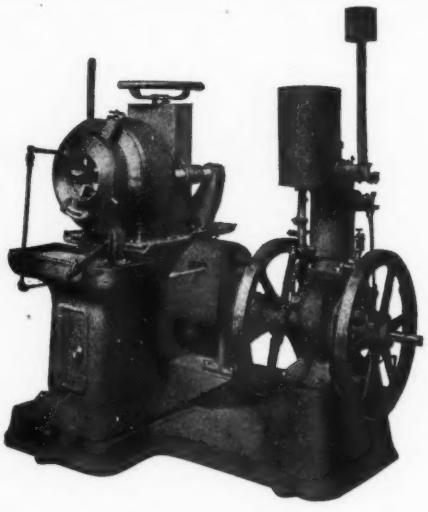

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Gas Engine Driven Outfit is self-contained and stands always ready for instant use. Requires no outside power. As a cost reducer it has no equal.

We are experts along all lines and classes of pipe threading, guaranteeing complete satisfaction in every case. Write for catalog.

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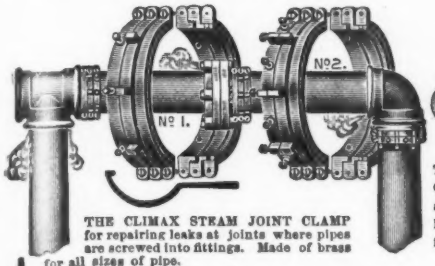

THE CLIMAX STEAM JOINT CLAMP for repairing leaks at joints where pipes are screwed into fittings. Made of brass for all sizes of pipe.

THE EMERGENCY PIPE CLAMP, for repairing splits and rust holes. Made of malleable iron from ½ in. to 12 inches.

PIPE REPAIRS FOR ANY CONDITION

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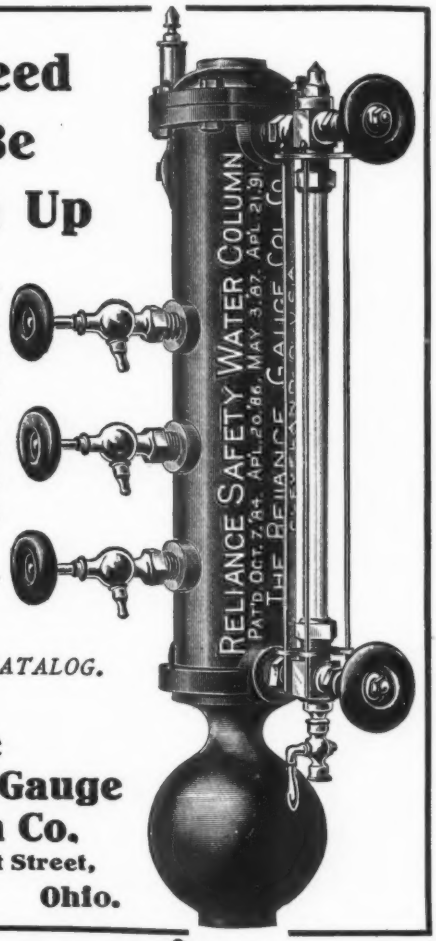
either by an exploding boiler when the water runs low or by the boss when the water runs high and wastes fuel.



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The valve pencil is made of selected metal of lasting quality—1" long. It is the only part that ever needs renewing, and it can be worn down to the stem and then replaced for a few cents. The worn pencil is easily removed.

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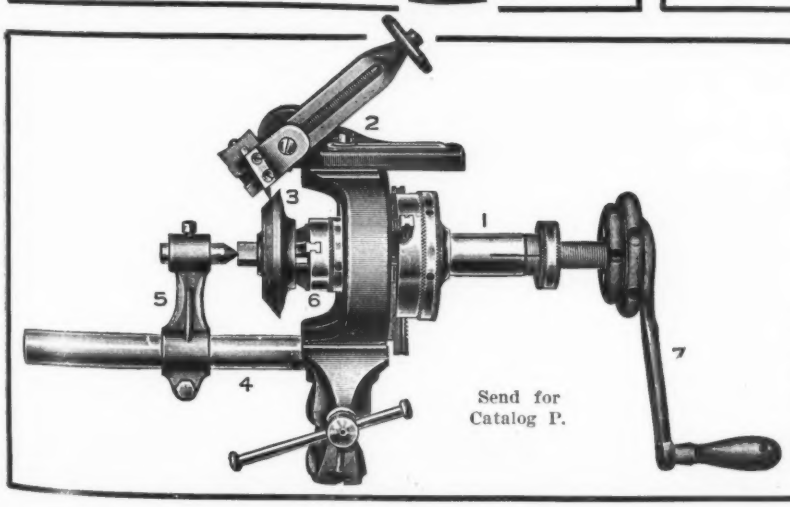

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Concealed leaks often cause trouble wherever valves are used. By applying a

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you'll discover valves badly out of true. They were leaking and you didn't know it. Every valve in the plant should be tested with a Dexter Machine. The operation is simple and then you'll know your valves are safe and sound.

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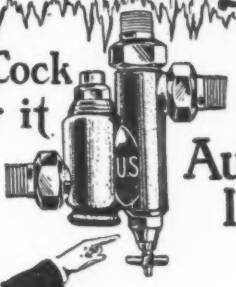
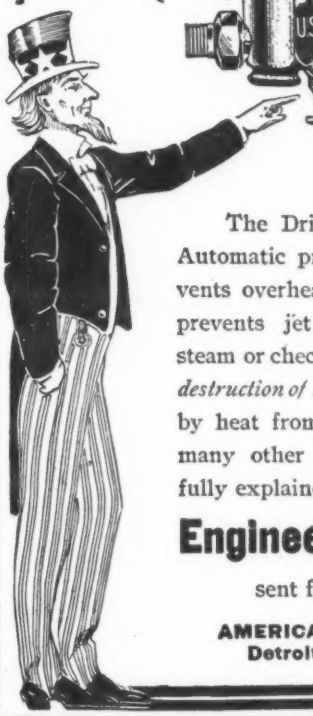
The Drip Cock prevents it



U.S. Automatic Injector



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Chicago Automatic Injectors

Prove their Quality in Actual Operation

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It is positive in its work and has nothing to get out of order. Built unusually strong.

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The Best Oil Is Better And Cheaper

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because the graphite closes up the inequalities of the bearing surface and makes it unnecessary to use so much oil.

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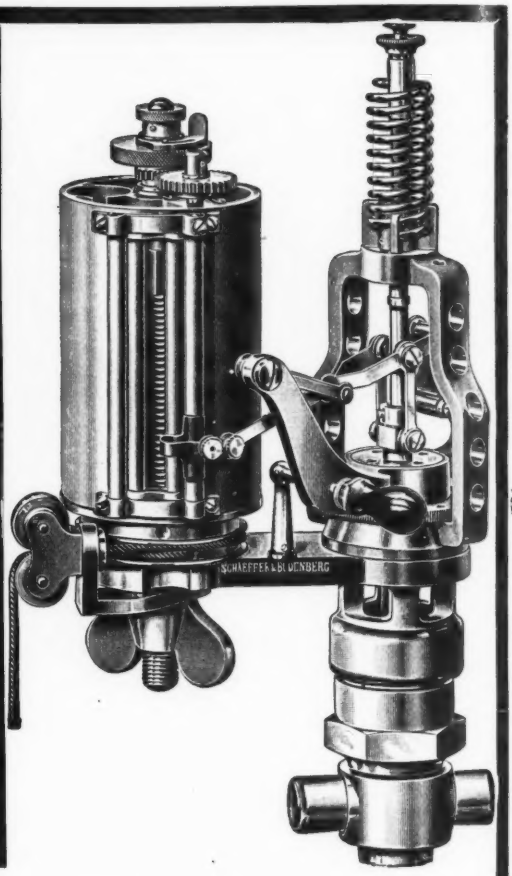

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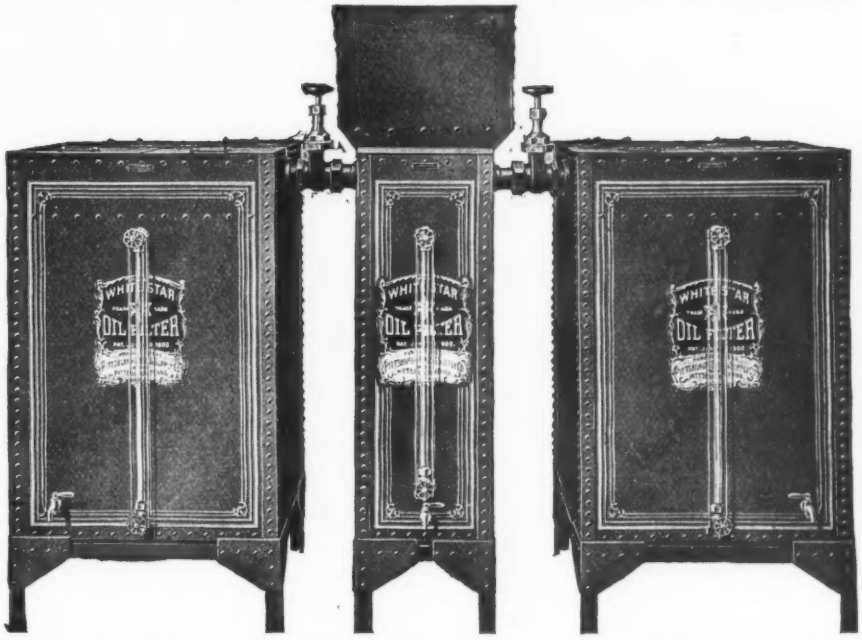
Nothing too large.



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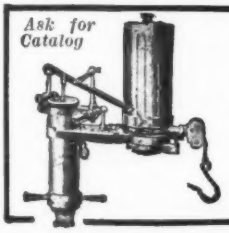

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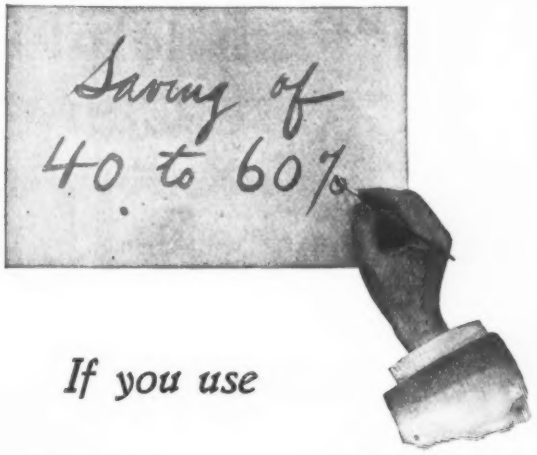

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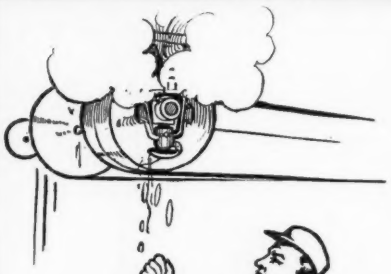

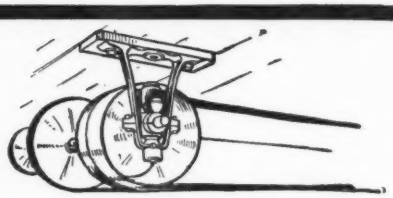

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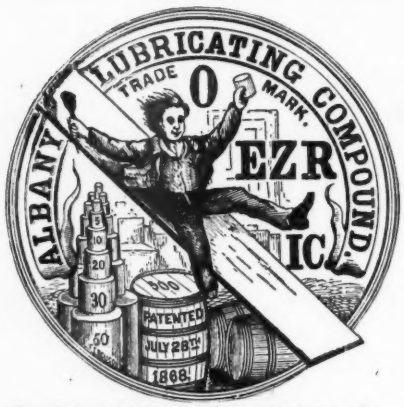

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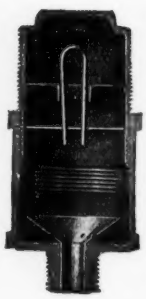

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Detroit Improved Standard Lubricator

Some One

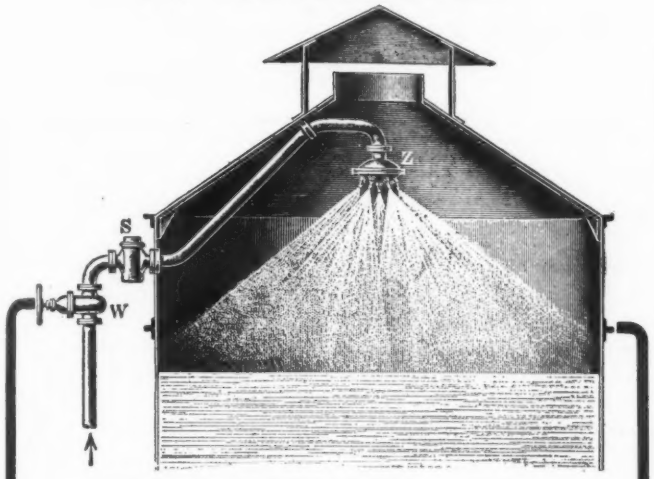
of our 337 different styles and sizes of sight-feed lubricators will fill any requirement you may have.

When ordering, insist on getting the genuine Detroit.

Write for a catalog of the most complete line of oiling devices for all purposes.

DETROIT LUBRICATOR COMPANY.
Detroit, U. S. A.

Washing Crude Oil
IN REFINERIES



The treatment of crude oil in agitators using simply perforated pipes requires much water, and besides the crude oil is not covered properly, and a perfect cleansing of the oil is not accomplished.

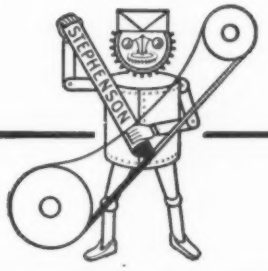
By using the Koerting Centrifugal Spray Nozzles, as shown in above illustration, this disadvantage does not take place. Our Spray Nozzles save time, water and cleanse perfectly.

Write for catalog 6-A.

SCHUTTE & KOERTING CO.,

Tompson & 12th Sts., PHILADELPHIA.

NEW YORK, 50 Church St. CHICAGO, 805 Security Bldg.
BOSTON, 98 High St. PITTSBURG, Keenan Bldg.
G. C. Goeriz & Co., SAN FRANCISCO



THE AFTER EFFECTS ARE PLEASANT

Don't waste good belts and lose valuable power. **STEPHENSON Bar Belt Dressings** contain no Rosin nor any other ingredients injurious to Belting. Our **RED Label** and **GREEN Label Brands** are two entirely different and distinct preparations. No **one** kind of Dressing is good for **all** Belts—you know that. **STEPHENSON Dressing** not only prevents shpping and gives full speed from slack belts, but **the after effects are pleasant**—it KEEPS those belts in good condition and greatly prolongs their life.

This means a saving in BELTING, which is an important item when figuring the year's expenses.

RED Label Brand for Leather belts:
GREEN Label for Rubber and Canvas.

Your protection against substitution is **The Man with the Cog-Wheel Face** on each Pound Stick.

Of Dealers everywhere, or

STEPHENSON MFG. CO.
ALBANY, N. Y

OXoilOX

F. S. WALTON CO., Philadelphia.
Gentlemen:—Kindly send us free of all charge, a sample can of OXoilOX, the perfect belt dressing.

Name..... Name of Firm.....

Address..... Number of Belts..... Average size.....

F. S. WALTON CO., Philadelphia, Pa.

Pressers and Refiners of all grades of Neatsfoot Oil.

THE PERFECT BELT DRESSING

MADE from pure neatsfoot oil, but as different and improved as broad cloth is over raw wool. Contains absolutely **no** resin or tallow; nothing to make belts heavy or sticky; it's a **"food"**, not a dope; it restores to leather the strength and vitality lost in tanning; keeps belts soft, and tough and clean. There's **"life"** in them when treated with **OXoilOX.** They cling so closely to pulleys that air is absolutely excluded, and the belts run slack at full load without slipping.

Saves the belt, saves the bearings, saves power; —you "need it in your business."

FOR WORK IN PLACES WHERE OTHERS FAIL

DUXBAK BELTING
TRADE MARK

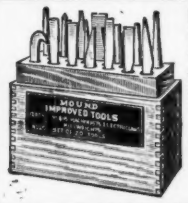
"DUXBAK" LEATHER BELTING

Will always give highest grade results and will last indefinitely. Both the Steamproof and Waterproof can be relied upon for perfect service. Sent on approval in every case.

Chas. A. Schieren Company
ESTABLISHED 1868

Tanners, Belt Manufacturers. **69 Cliff St., New York.**

Chicago, 84-86-88 Franklin St. Pittsburg, 240 Third Ave. Boston, 186-188 Lincoln St. Denver, 1622 Wazee St. Philadelphia, 226 North Third St. Brooklyn, N. Y., 13th St. and 3rd Ave. Hamburg, Germany, Auf dem Sande 1. OAK LEATHER TANNERIES, Bristol, Tenn.



MOUND TOOLS. FOR THE ENGINE ROOM.

This cut represents our new set of 20 tools gotten up for use in the engine room. Strictly high-grade tools with all the good points of toolsmithing in their make-up. Conveniently arranged in finished Oak Case and every tool is guaranteed.

No. 20 Set of 20 Tools . . . $4.00.

Book "Engineers' Chums" free. Address Dept. B

MOUND TOOL AND SCRAPER CO.
1606-1608 N. BROADWAY, ST. LOUIS, U. S. A.

SAGINAW MANUFACTURING CO.,
SAGINAW, MICH., U. S. A.
MANUFACTURERS OF
GILBERT WOOD SPLIT PULLEYS.
New York Branch, 88 Warren Street.
Chicago Branch, 32 South Canal Street.
Sales Agencies in all principal cities.
Cable Address, "Engrave" A. B. C. and Lieber's Code.

Robins Laminated Leather Belting

Is made continuous without laps, plies or cement. Guarantees an equal distribution of strength and an uninterrupted line of power transmission.

Write for circular No. 2.

ROBINS NEW CONVEYOR COMPANY

New York, 38 Wall Street | Factory, 168 Duane Street | Chicago, Old Colony Bldg.

RHOADS LEATHER BELTING

The one specification—it gives the service

J. E. Rhoads & Sons

PHILADELPHIA 12 N. THIRD ST. BOSTON NEW YORK 40 FULTON ST.

HAMBLET & HAYES CO., EASTERN AGENTS, 105-111 SUMMER ST.

FACTORY, WILMINGTON, DEL.

Belting Logic—If best Leather Belting costs per sq. ft. $1.00, best Rubber Belting 60c., and best Stitched Canvas Belting 40c., and with Leather showing 25% and Rubber 50% of the strength of **Best Stitched Canvas Belting,** wouldn't it be good policy for you as a practical man to investigate the merits of our product? Send for Book "C."

SAWYER BELTING COMPANY, **CLEVELAND, OHIO.**

HAVE YOU TRIED SHULTZ SABLE BELTING?

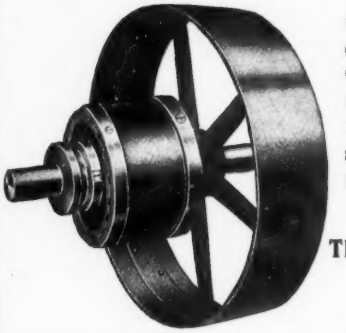
Sable Belting will save money for you, if you give it a chance. Tell us your requirements and we will send a belt for 60 days' free trial. WRITE FOR BOOKLET.

SHULTZ BELTING CO.,
ST. LOUIS, MO.

New York | Boston | Philadelphia

33 A

Notice How Smooth



is the outer surface of the Akron Friction Clutch, and we are ready to prove that the Akron takes hold and lets go just as smoothly.

CIRCULAR?

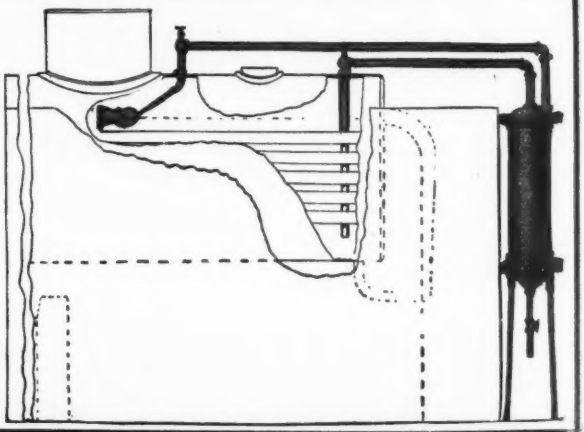
THE WILLIAMS FOUNDRY & MACHINE CO.,
AKRON, OHIO.
Successors to the Akron Clutch Co.

Always On The Level

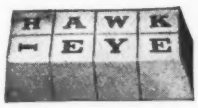
The Buckeye Boiler Skimmer is always on the water level withdrawing the impurities which rise to the surface, and thus preventing the formation of scale.

Your boiler is not complete without the Buckeye. Write today.

Buckeye Boiler Skimmer Co.
South End, Toledo, Ohio.



THE HAWK-EYE BOILER COMPOUND



NEVER FAILED.

See our Advertisement in First Issue Every Month.

HAWK-EYE COMPOUND CO.,

303-304-305 Merrick Block, CHICAGO, ILL.

Pyramid Boiler Compound

dissolves boiler scale and prevents the formation of more. It is *guaranteed* to make clean boilers. Ask for details.

Some territory still open for agents of the $5,000 class.

Binghamton Boiler Compound Co.,
Binghamton, New York.

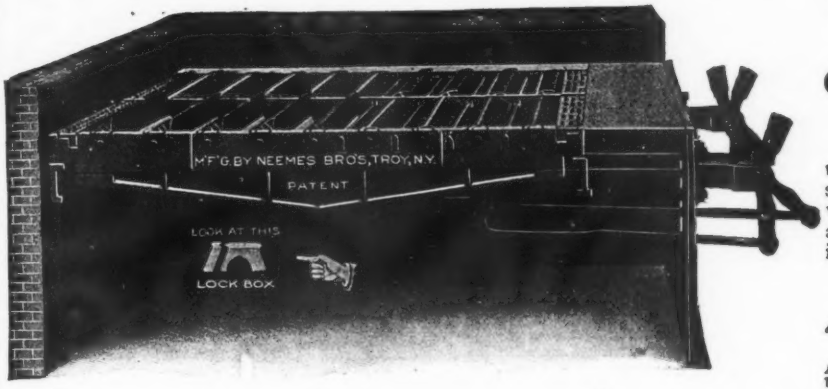
Los Angeles, Cal.; Seattle, Wash.; Portland, Oregon; Cincinnati, Ohio; Cleveland, Ohio; Providence, R.I.; Syracuse, N. Y.; Scranton, Pa., Louisville, Ky.; St. Louis, Mo.; Birmingham, Ala.

JEFFREY
Pivoted Bucket
CONVEYOR
HANDLING
Coal and Ashes in Power Plant

GRAB BUCKETS, STORAGE BINS, CRUSHERS, SCREENS, Etc.

The Jeffrey Mfg. Co.,
Columbus, Ohio, U. S. A.

New York Chicago Boston
Pittsburg Denver Charleston
Knoxville St. Louis Montreal



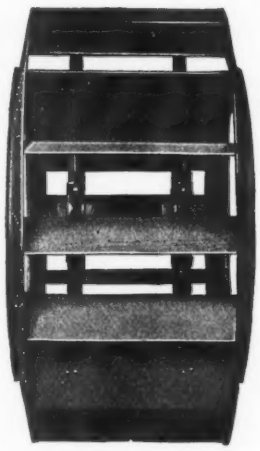
NEEMES BROS.
IMPROVED
Clinker Cutting, Shaking and Dumping Grate

unlike all other grates will cut from both sides of the shaker alike. Makes more steam with cheaper fuel and less of it. A slight agitation shakes out the ashes or a full opening dumps everything into the ashpit. *Write.*

NEEMES BROS.,
41-49 Adams St., TROY, NEW YORK

C. W. VAN BLARCOM, Room 533, Terminal Bldg., 30 Church St., Agent for New York City and vicinity. BABCOCK & WILCOX, Ltd., Montreal, Canada, Sole makers for Canada. BURKE ENGINEERING CO., 311 Industrial Bldg., Providence, R. I., Sole Agents for the New England States.

THE MOST EFFICIENT VENTILATING FAN



in the **WORLD** is the

STURTEVANT

For Low Speed Large Volume

For High Speed Large Volume

STURTEVANT FANS are selected to save power; they are just right in both speed and volume.

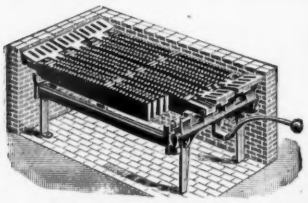
B. F. STURTEVANT CO., Boston, Mass.

General Office and Works, Hyde Park, Mass.

NEW YORK PHILADELPHIA CHICAGO CINCINNATI LONDON

Designers and Builders of Heating, Ventilating, Drying and Mechanical Draft Apparatus; Fan Blowers and Exhausters, Rotary Blowers and Exhausters; Steam Engines, Electric Motors and Steam Turbines; Pneumatic Separators, Fuel Economizers, Forges, Exhaust Heads, Steam Traps, etc.

680



THE RYDER STYLE ROLLER GRATE

SALAMANDER GRATES

Twenty different styles, all made of same grade of iron—the best for the purpose. On the market for 55 years. Tried and true.

SALAMANDER GRATE BAR CO.
126 Liberty Street, New York

ROGERS STATIONARY GRATE

COMMON PLAIN GRATE—SINGLE

WE guarantee the "Wing" to increase any boiler's capacity 25% over rating if desired. CATALOG?

L. J. WING MFG. CO.,
90 West St., Cor. Cedar St., NEW YORK.

ANY TYPE OF BOILER

The Murphy Automatic Smokeless Furnace

burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.

MURPHY IRON WORKS, 5 Walker St., DETROIT, MICH.
UNITS OF ANY SIZE

PREVENT SMOKE

Write to us for descriptive matter relating to a device that is mechanically correct, simple in construction, absolutely automatic, and its effectiveness in preventing smoke from Bituminous coal under any and all conditions has been fully demonstrated.

CLIMAX SMOKE PREVENTER COMPANY
205 Equitable Building, Boston, Mass.

CHIMNEYS

WIEDERHOLDT CONSTRUCTION CO.
American Trust Bldg., Chicago, Ill.

Over 7500 Hammel Oil Burners
In use under Stationary Boilers, Locomotives, Kilns, Etc.
Write for Circular of Hammel Patent Furnace for Water-Tube Boilers
HAMMEL OIL BURNER CO.
609 North Main Street, LOS ANGELES, CAL.

THE MONARCH A metallic backing faced with fire brick. Hangs from above. *WRITE* **BOILER ARCH**

MAYVILLE SPECIALTY MFG. CO.
MAYVILLE, WIS.

Turn Dead Loss Into Live Profit

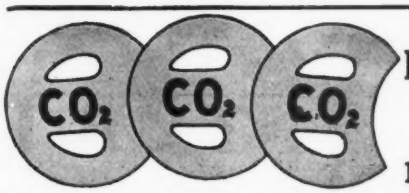
In other words burn your fuel clean with a Wilkinson Automatic Stoker and Smoke Preventer instead of squirting 15% of the coal at the sky and—but that's another story and you'll find it in our Catalog.

The Wilkinson Manufacturing Co.,
Bridgeport, Montgomery County, Pa.

MARTIN GRATES

Martin Anti-Friction Rocking Grates will burn slack coal and get the same steam results as ordinary grates do with best lump coal. Catalog tells why.

MARTIN GRATE COMPANY, 281 Dearborn Street, CHICAGO.



C-O-Two Tile
FIRE ARCHES
Any Rise, Any Span,
Air Baffle Mixing System
produces
RESULTS

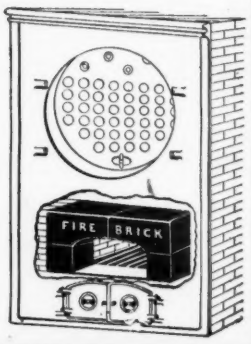
C-O-TWO FURNACE COMPANY, Syracuse, N. Y.

HEAT PROOF

The heat resistance of our fire brick is wonderful. We fit every type of boiler setting.

Write for catalog and prices.

Presbrey Fire Brick Works,
Taunton, Mass.



CONTRACTORS.
CENTRAL STATION HEATING.
Write for valuable information.

AMERICAN DISTRICT STEAM CO.,
Lockport, N. Y. Toronto, Can. Chicago.

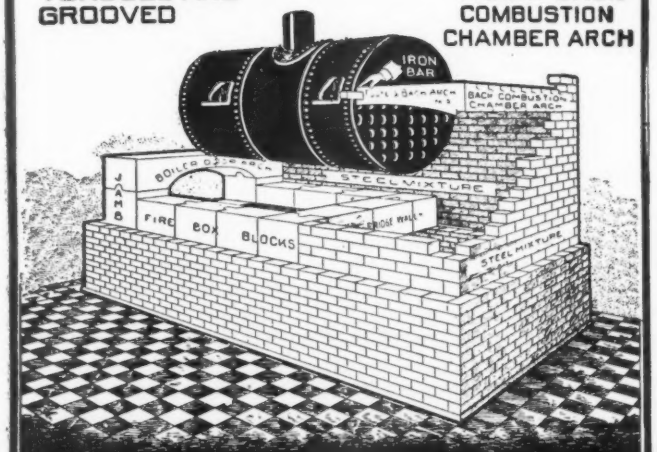
GREEN CHAIN GRATE STOKERS
AUTOMATIC SELF-CLEANING SMOKELESS
GREEN ENGINEERING CO.
COMMERCIAL NATIONAL BANK BLDG., CHICAGO
GENERAL FOUNDRY WORK A SPECIALTY

"STEEL MIXTURE"

BOILER DOOR ARCHES AND FIRE BOX BLOCKS

TONGUED AND GROOVED

PATENT BACK COMBUSTION CHAMBER ARCH



MANUFACTURED BY

McLEOD & HENRY CO.

TROY, N.Y., U.S.A.

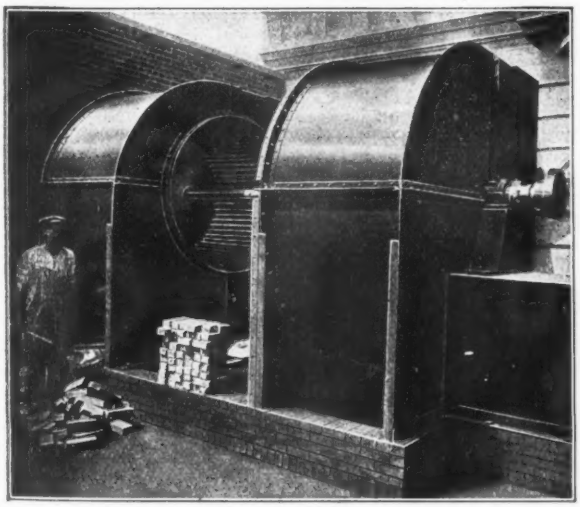
BRANCH OFFICE, 1402 BROADWAY, NEW YORK CITY.

"SIROCCO"

TRADE MARK

BLOWERS

BUILT ON THE TURBINE PRINCIPLE
MOST EFFICIENT FOR ALL DUTIES



VENTILATING INSTALLATION, HOTEL ASTOR, N. Y.

Two 66 inch Sirocco fans running on one shaft. Capacity: 50,000. cu. ft. per minute each against ¾ in. W. G. Power saving 25%

SIROCCO ENGINEERING CO.

138-140 Cedar St., New York. Works: Troy, N. Y.

Which is the Trained Man's Home?

It's in the home where training affects you most. It's in the home where the size of your pay envelope really counts. The **trained** man who holds a responsible position paying a good salary is able to have a home in which are found the luxuries of life.

The **untrained** man, who cannot do any one thing well, who must work by the day at jobs paying low wages, must put up with many hardships and do without a great many of the comforts of life.

But such a man can better himself if he chooses. An institution backed with a capital of six million dollars, whose sole business for 17 years has been to raise the salaries of ambitious men, will help him.

If **you** wish to better your position, increase your salary, and secure a happy and successful life, it is your duty to mark and mail this coupon. If your work is uncongenial, if you desire to advance in your trade, if you wish a better salary, find the way that thousands upon thousands of men have made their start for promotion and multiplied earnings. You do not have to leave home, buy books, or give up your present work. This is the most practical and simplest way in the world to secure promotion, so if you really want a better salary and a happy life, **make a definite attempt to get it by sending in this coupon NOW.**

International Correspondence Schools

Box 979, Scranton, Pa.

Please explain without further obligation on my part, how I can qualify for a higher salary and advancement to the position before which I have marked X

Electrical Engineer	Machine Designer	Sanitary Engineer
Elec.-Lighting Supt.	Mechanical Draft.	Architect
Elec.-Railway Supt.	Foreman Machinist	Architect'l Drafts.
Electrician	Foreman Toolmaker	Ad Writer
Telephone Engineer	Foreman Molder	Window Dresser
Civil Engineer	Foreman Blacksmith	Chemist
Bridge Engineer	Marine Engineer	Sheet-Metal Draft.
Mechanical Engineer	Hydraulic Engineer	Ornament. Design.
Stationary Engineer	Municipal Eng.	Textile Designer
Gas Engineer	R. R. Const. Eng.	Bookkeeper
Refrigeration Eng.	Surveyor	Stenographer
Traction Engineer	Mining Engineer	Civil Service Exams.

Name_____

Street & No._____

City_____ State_____

What Do YOU Do When You Have Motor Troubles?

YOU have motor troubles occasionally, don't you? Some mighty troublesome troubles, too. You've spent many a weary hour and many a worried minute trying to locate and remedy the trouble. ¶ For every motor trouble there is a cause. For every cause there is a remedy. There's a way to locate every cause and apply the remedy. There's not one engineer in a thousand who knows all the ways and all the remedies. Not one in a hundred electrical experts does either. You've got to *live* with motors, eat with 'em, sleep with 'em, fairly spend your days and nights watching their eccentricities; you've got to know them from the ground up, forward and backward, before you can learn them thoroughly *from personal experience.* ¶ But now you can buy the condensed experiences of a man who does know motors inside and out, who has learned their every trouble, who knows the quickest and best ways of tracing, locating and remedying motor troubles. E. B. Raymond, Electrical Engineer of the General Electric Company, is the man,

Motor Troubles

is the book. In it you will find the quickest, easiest and best methods for tracing, locating and correcting direct-current and alternating-current motor troubles and for testing direct- and alternating-current machinery. ¶ It tells the whole story of Starting Up; Sparking; Brush Troubles; Characteristics of the Induction Motor; Locating Faults in Induction Motors; Winding Faults; Balking of Induction Motors; Mechanical Troubles; Troubles with Synchronous Motors; Testing Generators; Testing Direct-Current Motors; Testing Induction Motors, etc. Illustrates every point necessary. ¶ The price is $1.50 and if you'll send us the amount, you can examine the book thoroughly and then return it within 5 days of receipt and get your money back if it doesn't satisfy you completely. ¶ You can't eliminate motor troubles entirely but you can end the burden of worry and work attendant upon them if you accept this proposition *today.*

P
11-24

Mail this today.

HILL PUBLISHING COMPANY, 505 Pearl Street, New York City

Enclosed find $1.50. Send me Motor Troubles subject to your guarantee.

Name .....

St. & No. .....

City & State .....

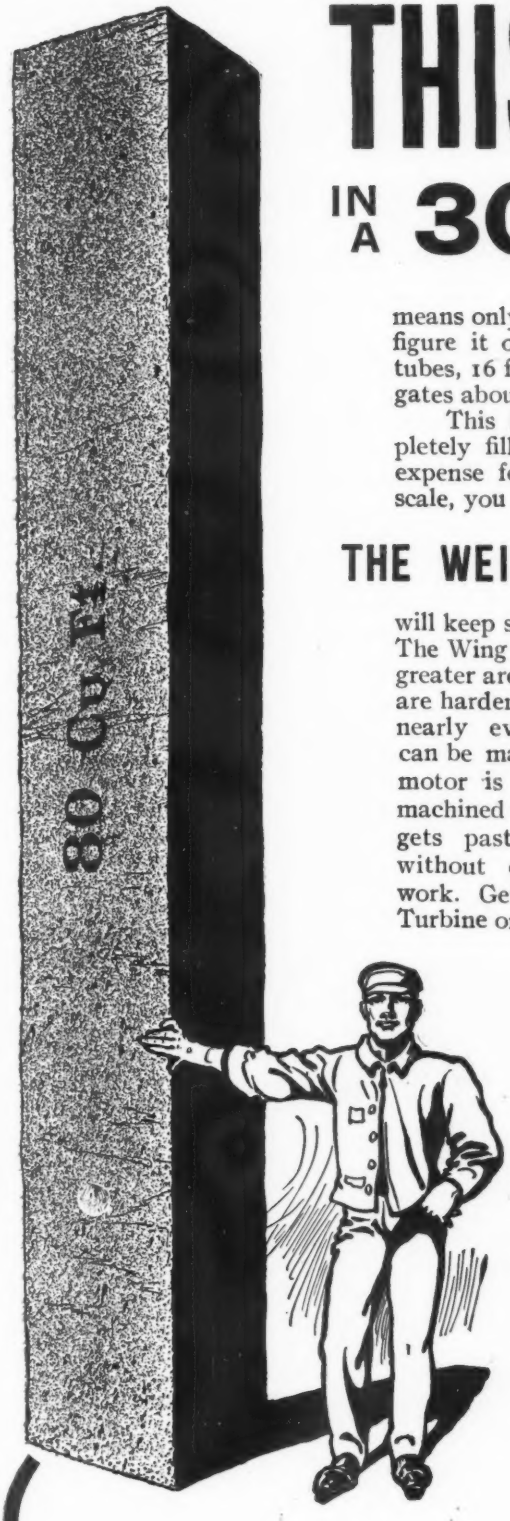
Cut Off Here and Mail Now

Hill Publishing Company

505 Pearl Street, New York City

Power and The Engineer *American Machinist*

The Engineering and Mining Journal



THIS MUCH SCALE IN A 300 H.P. BOILER

means only a layer ⅜ inch thick. Seems surprising, doesn't it, but figure it out for yourself. In a 300 H.P. boiler, for instance, 144 tubes, 16 ft. x 4 in., you will find that a ⅜ inch layer of scale aggregates about 80 cubic feet.

This isn't exceptional either, for we frequently find tubes completely filled. If you knew the amount of coal wasted, the extra expense for boiler repairs, etc., caused by even a small coating of scale, you would not allow it to collect.

THE WEINLAND WING ARM TURBINE CLEANER

will keep scale down to a negligible quantity, and do it at a low cost. The Wing Head is extra strong, has more cutters, and works over a greater area at once than any other turbine made. Its wearing parts are hardened steel—as nearly everlasting as can be made, and the motor is so carefully machined that no water gets past the wheel without doing useful work. Get a Weinland Turbine on trial. If you are not pleased with its work, send it back.

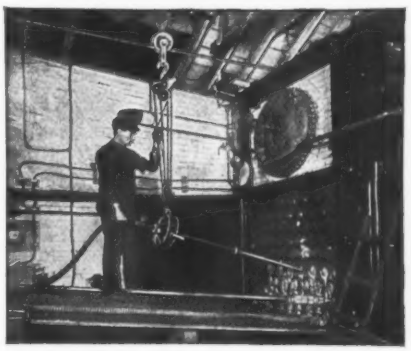
THE WEINLAND MECHANICAL CLEANER

removes the worst and thickest scale from any boiler.

No other cleaner has its power, and no other machine will cut costs so low where much cleaning must be done. Ask about our method of driving by direct air or steam motor.

We will rent this machine with privilege of purchase, or we will clean your boilers at a reasonable price. Our experts do a good job every time.

Write for our book, "Boiler Scale and Its Removal."



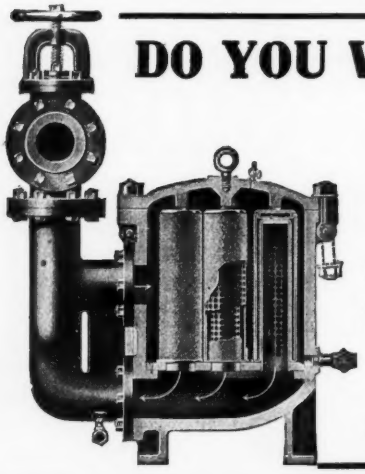
Weinland Steam or Air Driven Mechanical Cleaner removing ½ inch scale from one tube every 8½ minutes, at the plant of Foos Mfg. Co., Springfield, Ohio.

THE LAGONDA MFG. CO., Springfield, O.

Makers of Lagonda Automatic Cut-Off Valves, Reseating Machines and Tube Cutters

New York Philadelphia Pittsburg Chicago San Francisco Birmingham St. Paul Toledo London

(79)



DO YOU WASTE STEAM HEATING RETURNS?

Run this hot soft water of condensation through

THE BLACKBURN-SMITH FEED WATER FILTER AND GREASE EXTRACTOR

AND YOU NEED NEVER FEAR TROUBLE FROM THE OIL.

If you now waste these returns, you can pay for the filter with the heat and water saving it effects.

If you use the returns unfiltered, the oil deposit keeps the heat away from the boiler water, and may cause leaky tubes or worse. The advantage of the filter is evident either way.

Write today for our book "Feed Water Filtration."

106 Liberty St., JAMES BEGGS & CO., New York.

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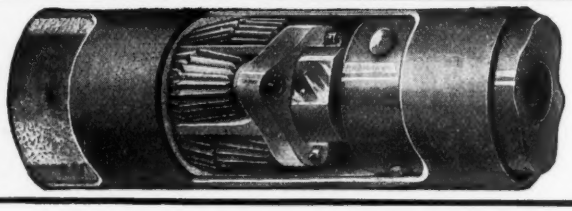

A Water Tube Cleaner Which Must Get All the Scale

Here is the front half of "DEMON" cleaner. Notice that its cutters are not thrown out by Centrifugal action but are *held fixedly* to the full size of tube.

Every tube *must* be cleaned perfectly. Don't fail to write for circular No 54, "Demon Cleaners vs Other Cleaners." Circular No. 56 describes the curved tube "DEMON." Folder No. 30 tells about the "TORPEDO" fire tube cleaner.

THE GENERAL SPECIALTY CO., 887 Niagara St., BUFFALO, N. Y.

Does Two Things at Once

Look for this Name

The Imitations do not have it, but your dealer buys them cheaper.

The Chesterton Combination

(TRADE MARK REG.)

Scrapes and Brushes the scale from the tubes and leaves them clean as new. The Protected spring is self-adjusting. The chilled cutting edges are more durable than steel. Your dealer, or write us direct.

A. W. Chesterton Co., 64 India St., Boston, Mass.

or Advance Packing & Supply Co., 123 Franklin St., Chicago, Ill.

The SIMPLICITY of the

"SWARTWOUT"

STEAM or OIL

SEPARATOR

is only surpassed by its efficient and positive action. It separates all water or oil from the steam by the vigorous whirling motion. The flow is direct without an ounce loss of pressure.

The Ohio Blower Co.

Cleveland, Ohio

Also Manufacturers of "Swartwout" Gravity Closing Ventilators.

1-64

Don't Let Your Engine Commit Suicide

by taking grit, oil or water from the steam. The cost of a Baum Separator is but a trifle compared to the repair cost it will save. We send the Baum free on trial.

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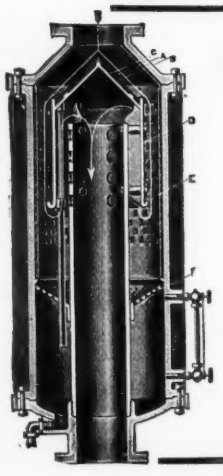

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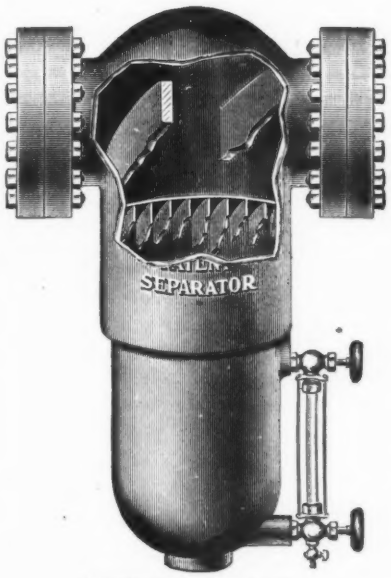
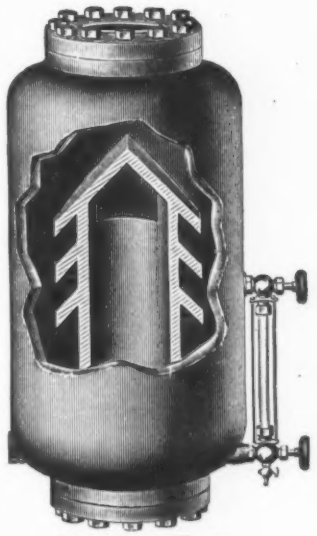


Horizontal Type

are based on a sound, common-sense *"bound-to-act"* principle which is totally different from the usual ideas embodied in separators that rely upon corrugated surfaces, perforated baffles or centrifugal force to do the work.

Our claim to superiority hinges upon *gravity*, utilized in such a manner as to positively remove the entrainment, with none of the uncertainty of action manifested in the usual types. For steam (live and exhaust), air, oil, ammonia and other gases, Liberty-Greenaway Separators give *guaranteed results.*



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Reducing Valves
Low Water Alarms
Safety Water Columns
Low Pressure Boiler Feeders

Valves
Pump Governors
Damper Regulators
Fan Engine Regulators
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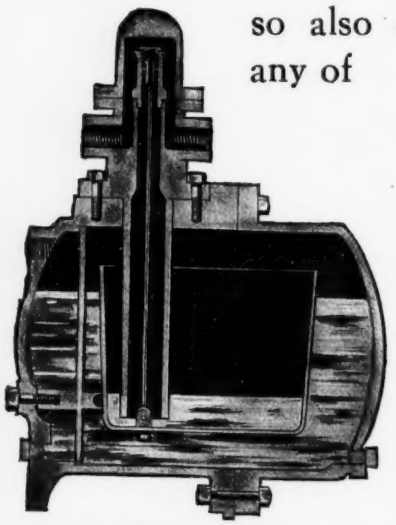

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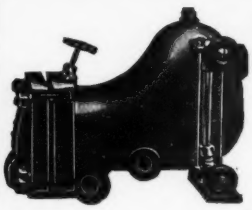

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are especially adapted for draining steam separators and high pressure mains. Also good for steam heating. All working parts are attached to the bonnet, and are removable with it. Valve outlets are large, to give rapid discharges of condensation.

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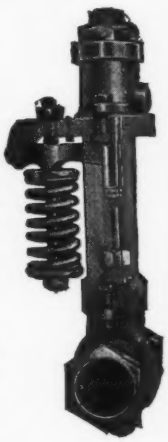

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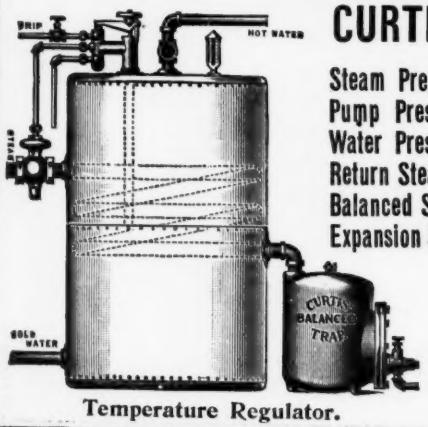

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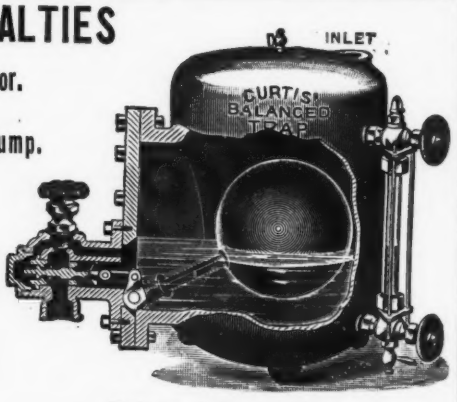
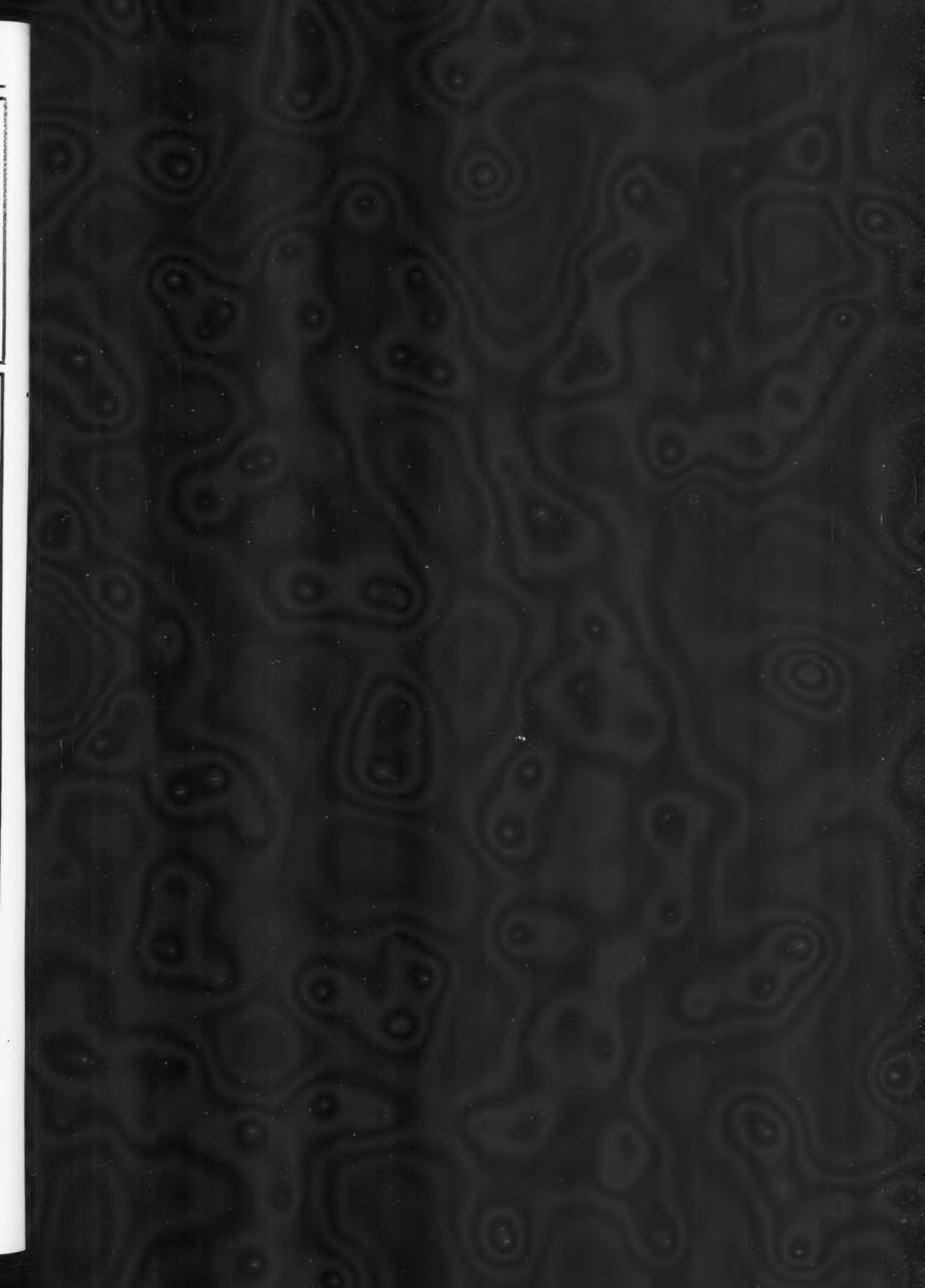
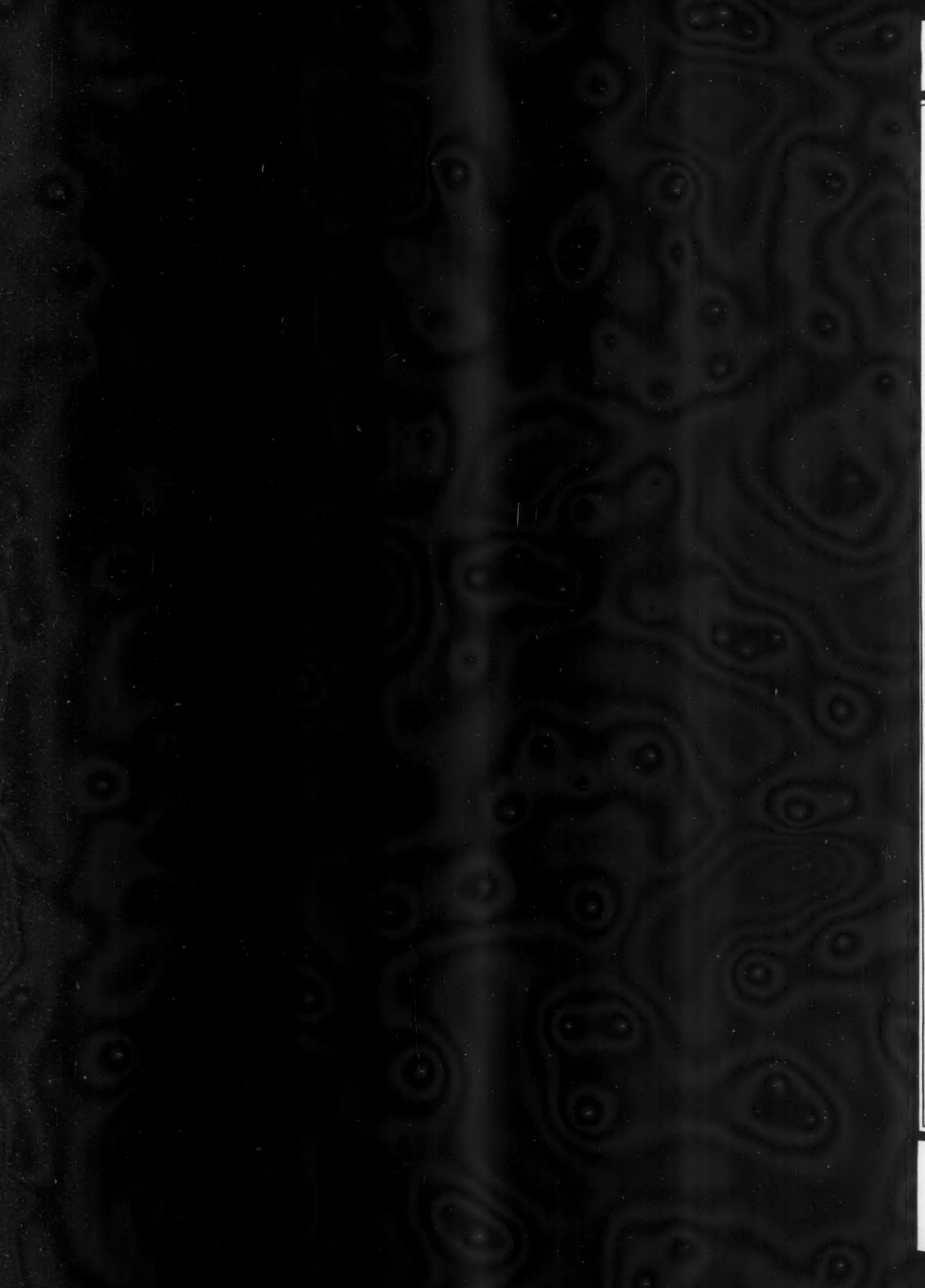


Balanced Steam Trap.





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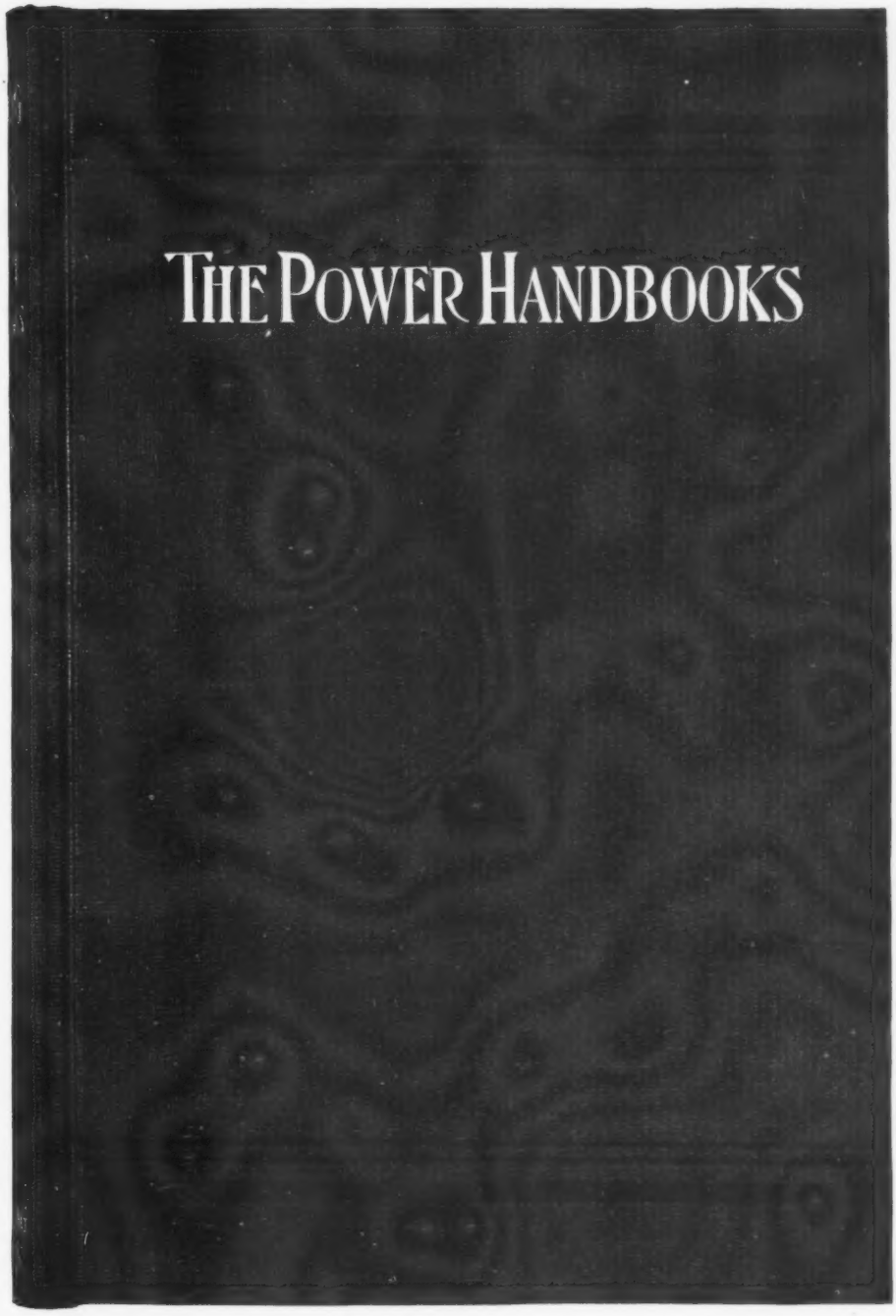

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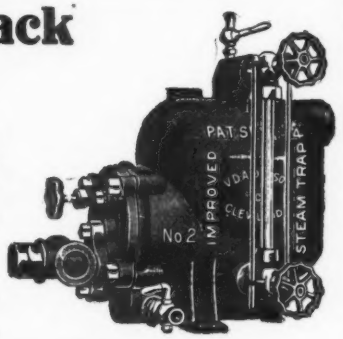

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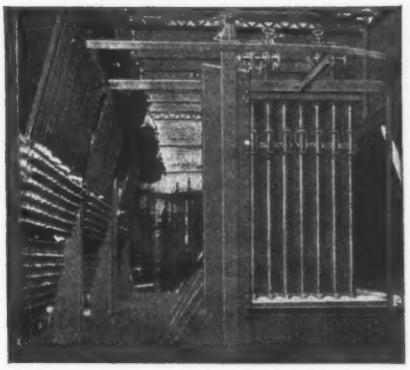

A Green Economizer, running 10 hours a day, will pay for itself in less than three years; running 24 hours a day its cost is returned in a year. At the same time, it is the most durable appliance in a steam plant. It lasts longer than the boilers. During one year the repairs, including labor, on $1,130,000 worth of Green Economizers in New England were $2,071.38, or less than two-tenths of 1 per cent. of the first cost. Not only this, but the economizer increases the life of the boilers and saves repair and cleaning bills, since it precipitates impurities in the feed water and prevents cold water from entering and straining the boilers.

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The Green Economizer has been perfected by 60 years of experience in building and installing economizers.

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Engineers; Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines. 135

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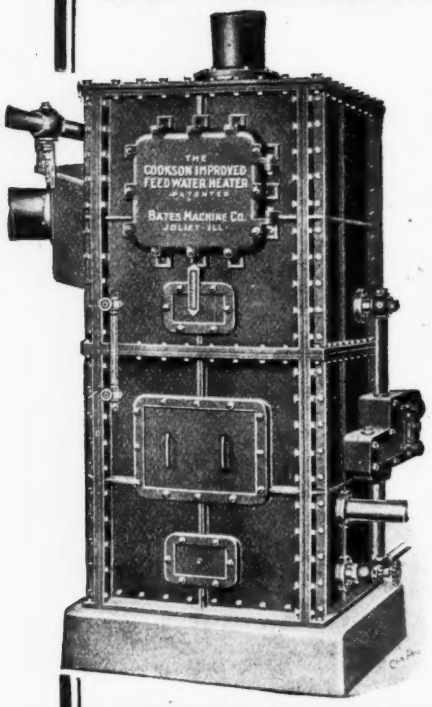

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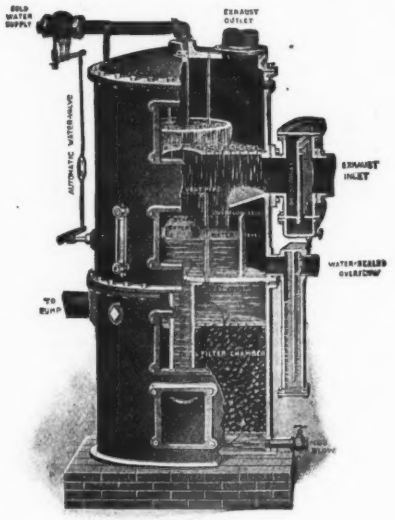

Perfect Oil Separation. Easily Cleaned. The Highest Possible Temperature in the Feed Water.

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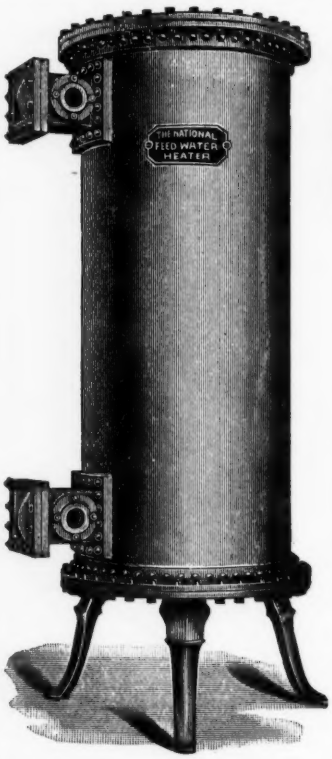

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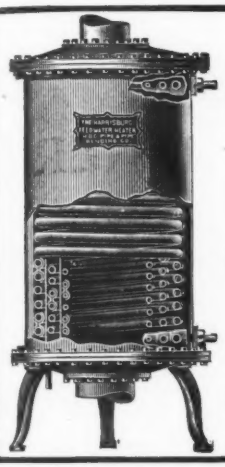

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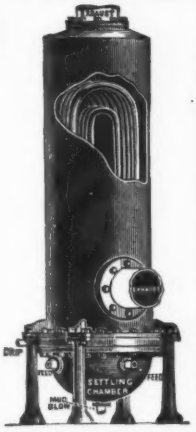

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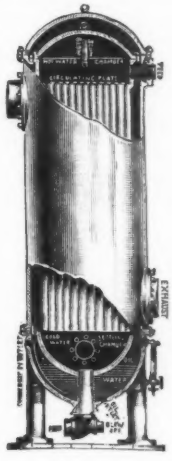

are so constructed that the tubes can expand or contract with perfect safety.

The combined area of all tubes in any size heater would be four or five times the area of the feed pipe. This feature with the circulating plate insures perfect circulation without back pressure. Write.

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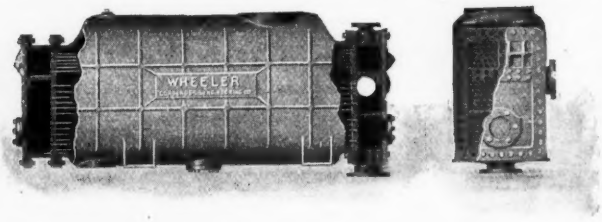

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Knowing that each 10° F. in the feed water means one per cent. less coal burned on the grates, engineers are frequently tempted to run with low vacuum, although high vacuum means steady economy. The ideal arrangement is to have the feed water, not only as hot as the water discharged by the air pump, but as hot as the steam when it leaves the engine cylinder.

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In the WHEELER-VOLZ COMBINED SURFACE CONDENSER and FEED WATER HEATER shown above, a heater is incorporated in the upper part of the condenser shell, certain tubes being set aside for heating the feed water and communicating with inlet and outlet passages separate from the regular circulating passages. These heater tubes are placed near the exhaust entrance and receive the full benefit of steam temperature. Moreover, they protect the condenser tubes from violent temperature changes, and relieve the condenser tubes of part of their work.

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WHEELER
CONDENSER & ENGINEERING CO.
CARTERET, NEW JERSEY.

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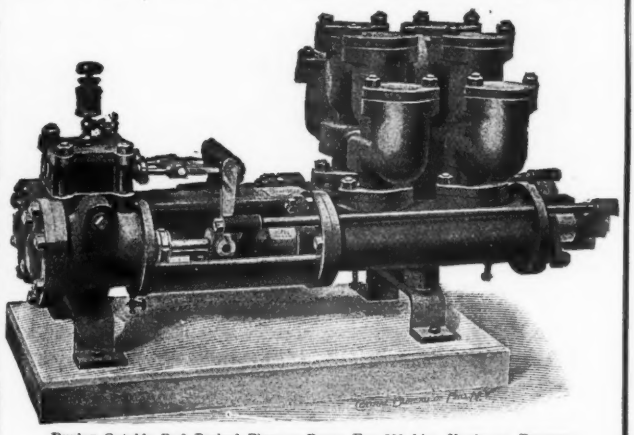
PUMPING MACHINERY



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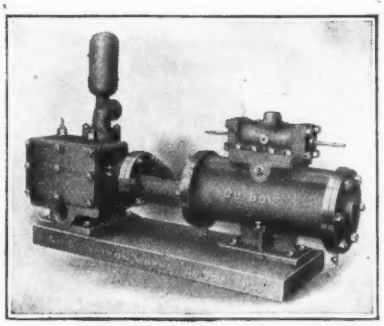

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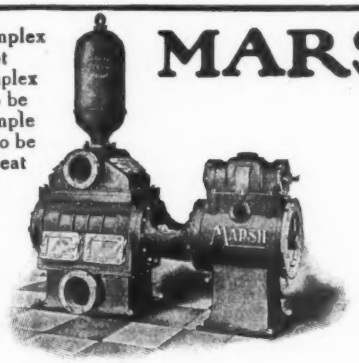

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are designed for handling hot as well as cold water. They are *at regular prices* fitted with bronze Piston Rods, bronze Water Cylinder Liners held in place by Studs, bronze Valve Seats, Stems, Nuts and glands. THE BEST OF MATERIAL AND THE BEST OF WORKMANSHIP ONLY GO INTO **MARSH PUMPS.**

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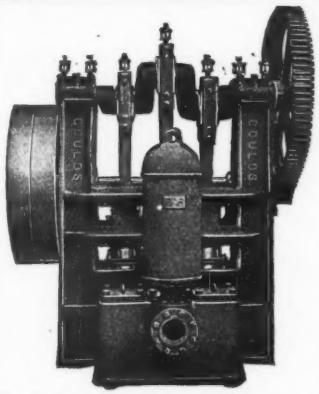

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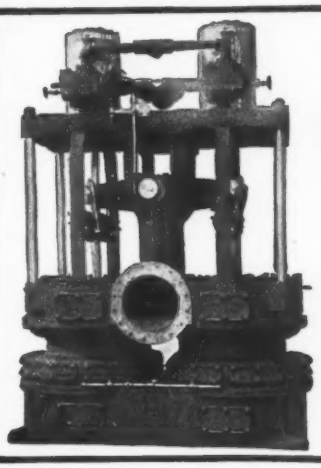

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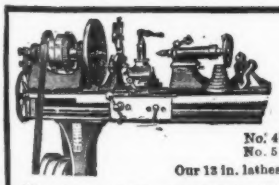

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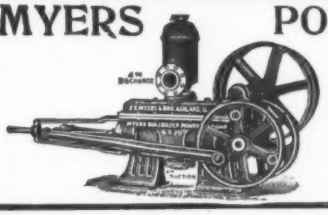

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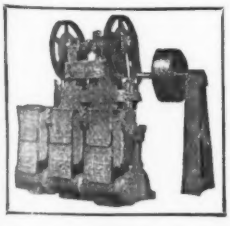

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Simple and Duplex Boiler Feeders. Jet and Surface Condensers. Power and Electric Pumps.

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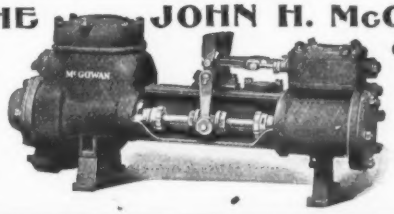

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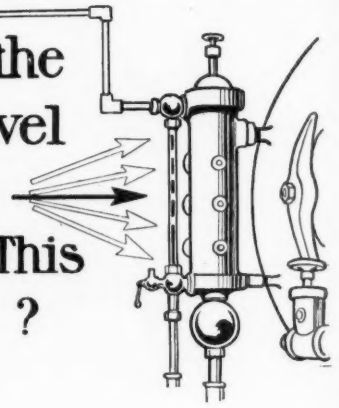

Can you say with absolute certainty without looking ?

Even if you do look, are you sure without trying the gauge cocks ?

And if the boiler is foaming a little, are you sure even then ?

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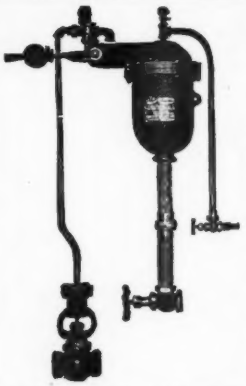

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for steam boilers was the first in the *field*, and has the longest and best record of any of these devices.

Costs Less to Operate and Maintain

Constructed on a different and better principle than any other.
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Balanced by
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Automatic
Feed Water
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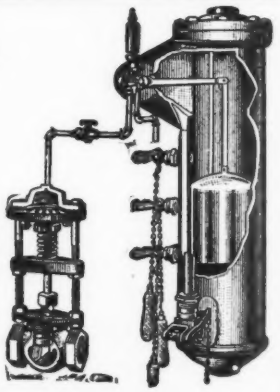

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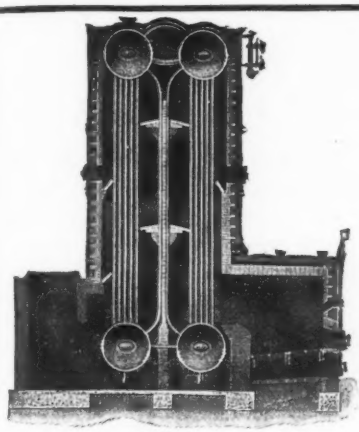

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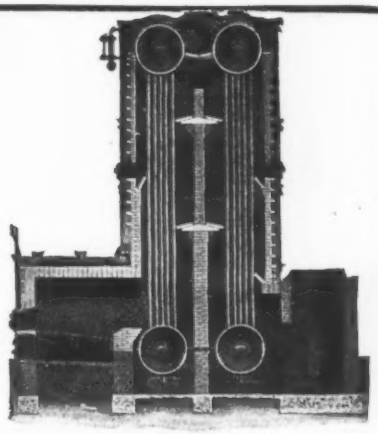

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MORRIN CLIMAX BOILERS

Are free from all weaknesses, make steam fast, hold the pressure under all conditions, and get FULL VALUE out of every scrap of coal and drop of water.

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Select This Governor

and your pumps and mains will be as safe as human contrivance can make them. **Buy Fisher Governors.** A poor governor is a false economy which is likely to prove immensely expensive. *Write.*

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The Gardner Governor is so constructed that, when a belt breaks or slips off the pulley, the valve instantly closes and everything stops.

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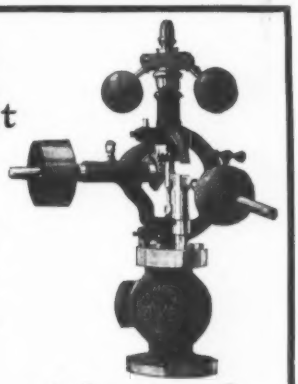

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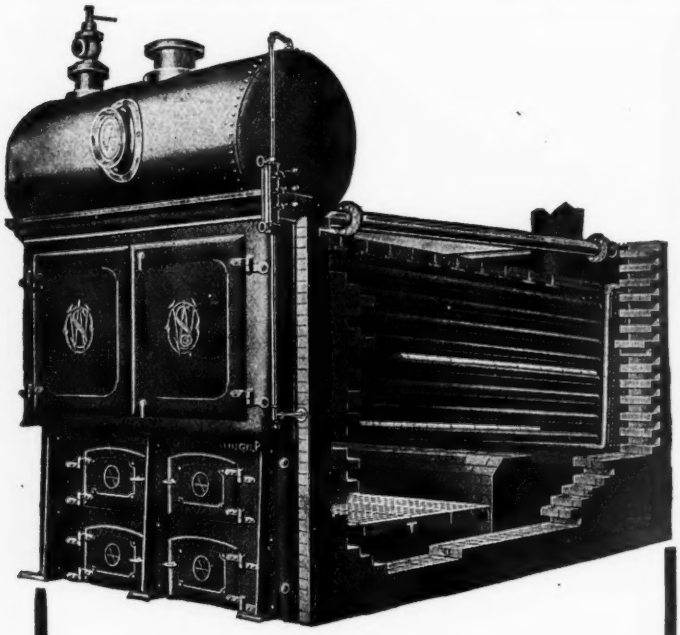

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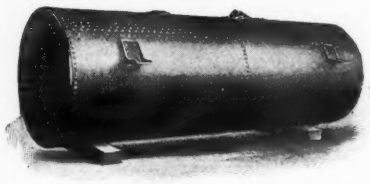

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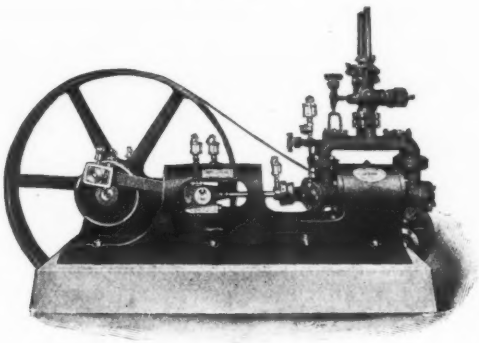

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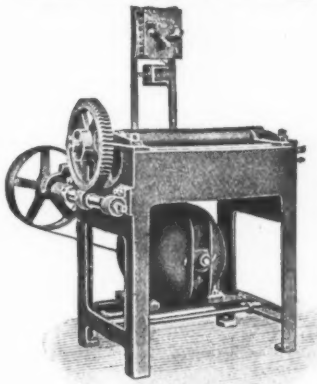

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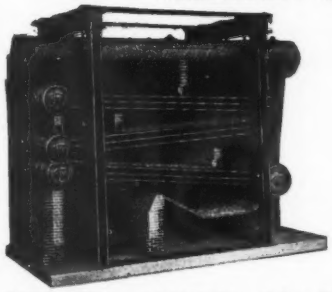

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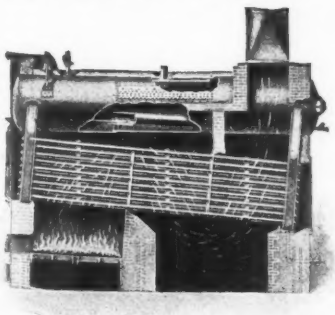

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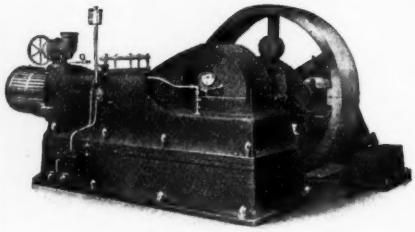

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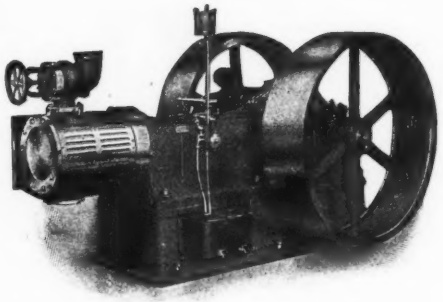

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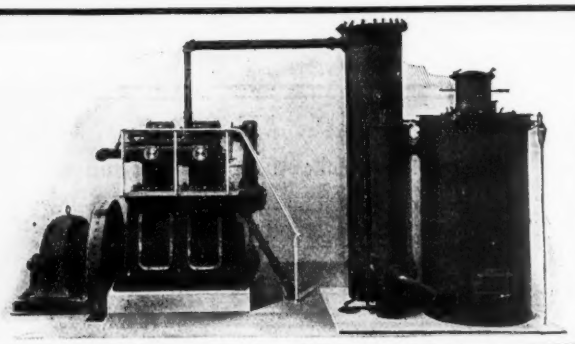

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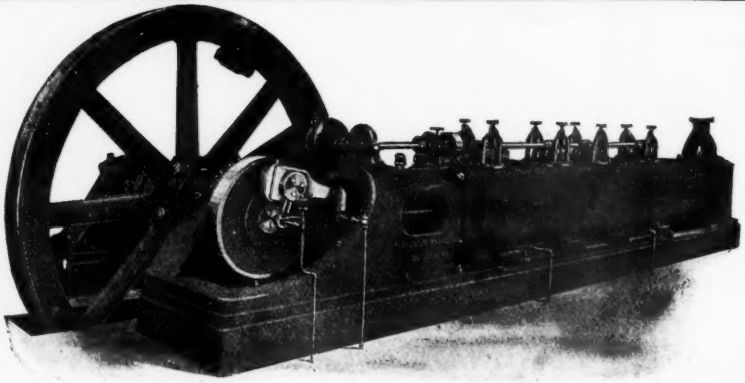

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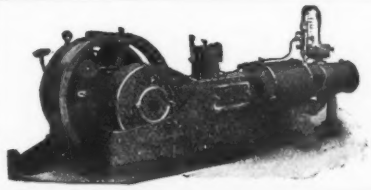

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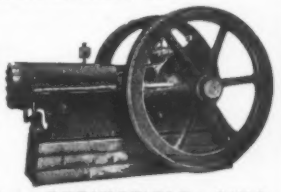

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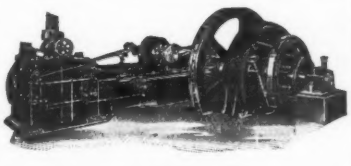

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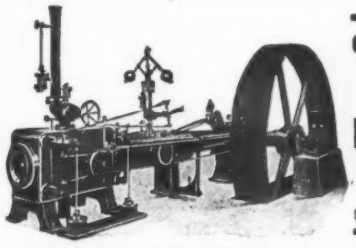

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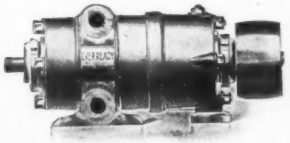

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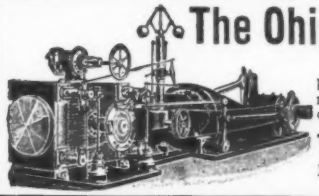

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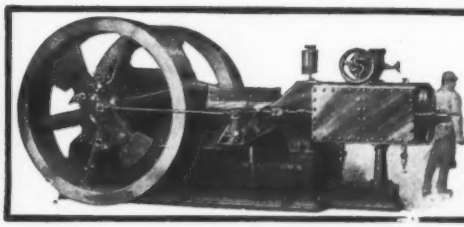

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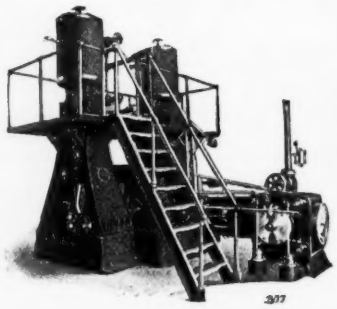

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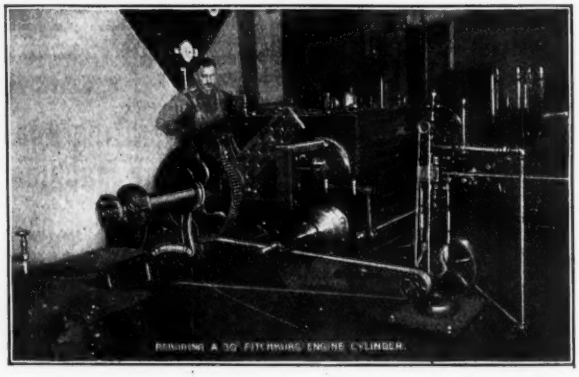

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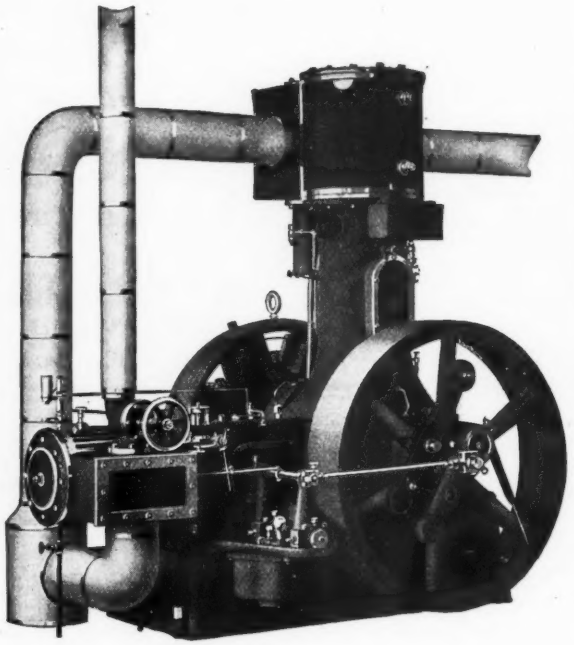

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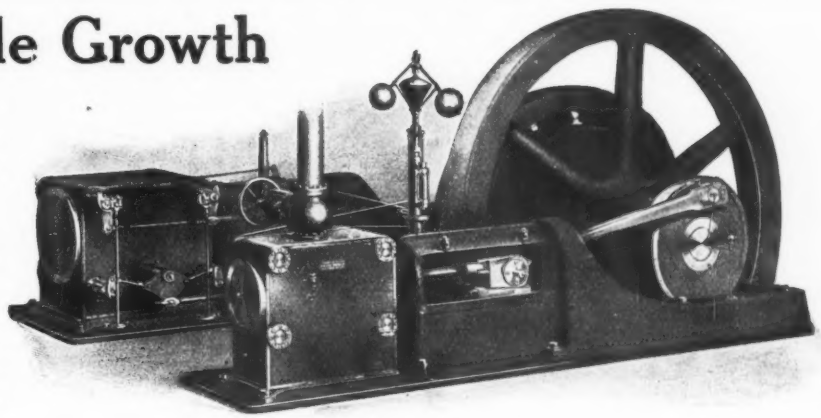

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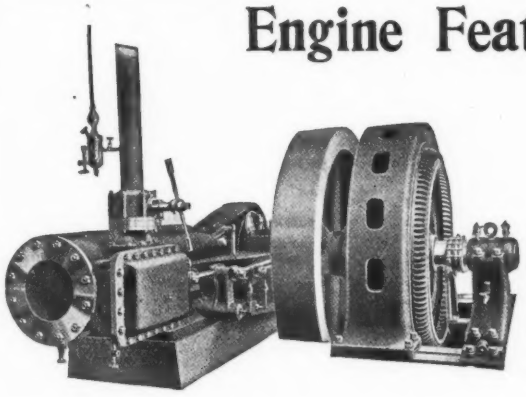

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Small Clearances
Free Steam Openings
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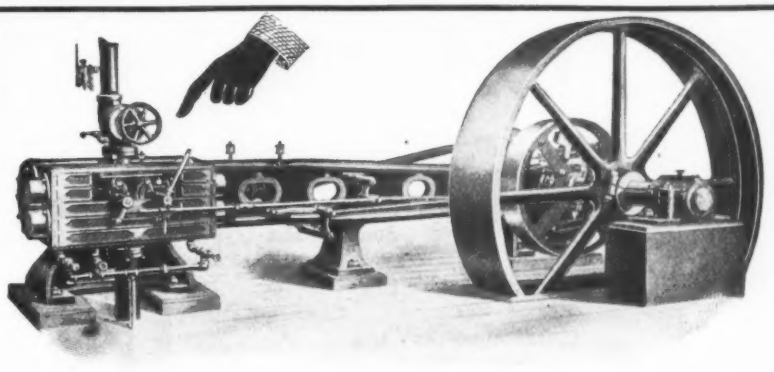

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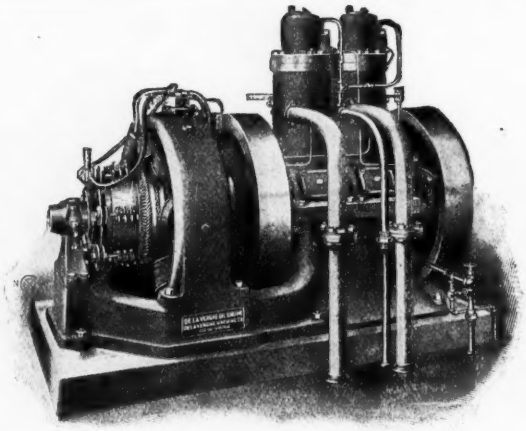

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are cheaper, simpler. more compact than any other motive power. 8 H. P. hours per gallon of cheap oil.

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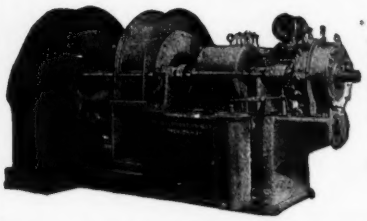

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The simplicity of the Curtis Turbine is not alone a feature of construction. It also contributes to valuable operating advantages. There are no internal wearing parts to cause a decrease in efficiency, after long periods of operation. Compare the view below of the working parts of the turbine with the corresponding parts of a steam engine and calculate the expense of piston packing, reboring cylinders, valve grinding and bearing linings for an engine which are avoided in the Curtis Turbine.

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And remember that no injury is done if the Curtis Turbine is flooded with water while in operation, and that it may be brought up to speed ready to carry the load almost instantly without the warming-up, draining, etc., customary with the reciprocating steam engine.

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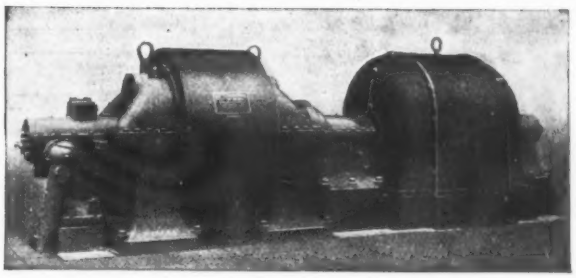
Westinghouse

A Westinghouse Exhaust-Steam Turbine



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operated on the exhaust steam from a non-condensing engine will double the power of the original engine without increasing the boiler plant.

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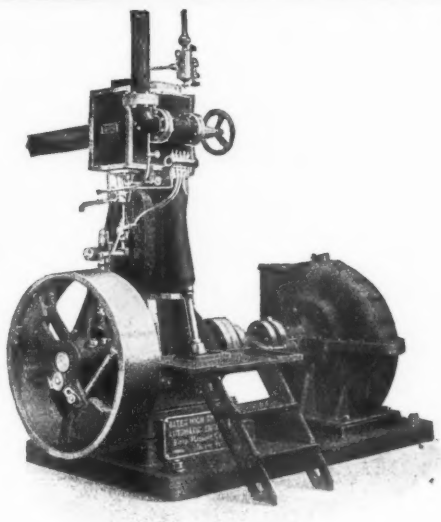

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and other places where it is desired to move a large volume of water at small expense.

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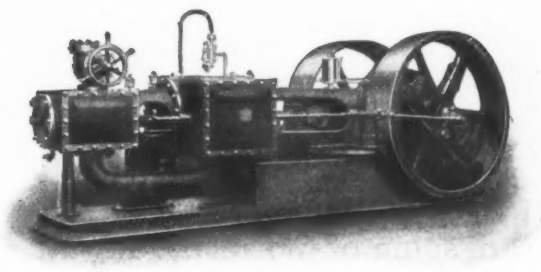
Rarely Requires Repairs



The Ridgway is therefore particularly suited to isolated plants. Write.

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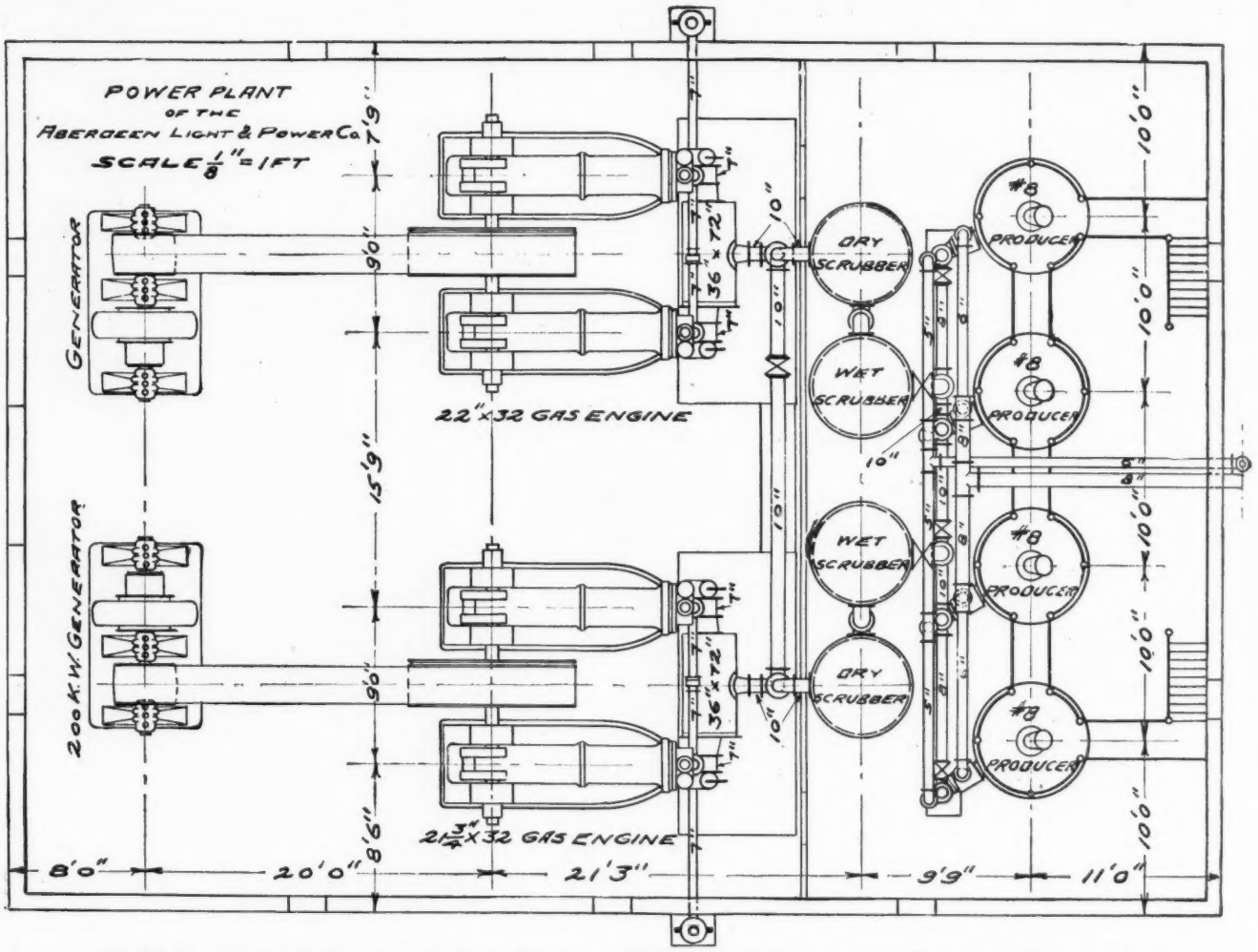

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The above is a plan of a municipal Electrical Power Plant showing Gas producers, wet and dry Gas Purifiers, Gas Engines and Electric Generators.

Suction Producers, operating on anthracite pea coal are employed. A considerable saving in floor space, the absence of a stack pouring out volumes of black smoke, and

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